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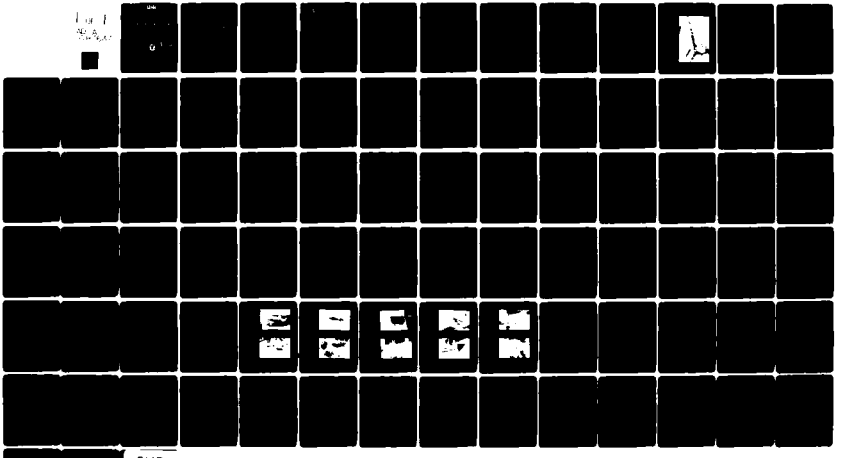

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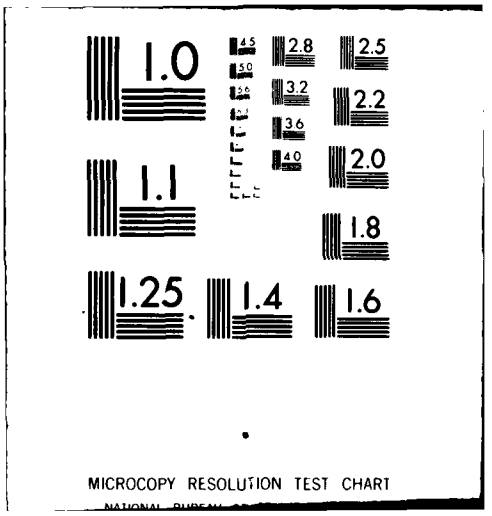
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LEVEL II

RARITAN RIVER BASIN
BIG BEAR BROOK, MERCER COUNTY
NEW JERSEY

AD A087637

GROVER'S MILL DAM
NJ 00155

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

MARCH 1980

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

10 Richard J. McDermott

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

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3. RECIPIENT'S CATALOG NUMBER:	
4. TITLE (and Subtitle): ~~Phase I Inspection Report~~ National Dam Safety Program. Grover's Mill Dam (NJ00155), Raritan River Basin, Big Bear Brook, ~~Mercer County, N.J.~~ Mercer County, New Jersey. Phase I Inspection Report	5. TYPE OF REPORT & PERIOD COVERED: 9 FINAL report
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7. AUTHOR(s): ~~RICHARD J. McDERMOTT~~	8. CONTRACT OR GRANT NUMBER(s): DACW61-79-C-0011
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Storch Engineers, 220 Ridgedale Ave., Florham Park, N.J. 07932	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS:
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Copies are obtainable from National Technical Information Service, Springfield, Virginia 22151.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dams	National Dam Safety Program
Embankments	Grover's Mill Dam, New Jersey
Visual Inspection	Spillway
Strucutral Analysis	Erosion

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-N

31 JUL 1980

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Grover's Mill Dam in Mercer County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Grover's Mill Dam, a high hazard potential structure, is judged to be in fair overall condition. The dam's spillway is considered inadequate because a flow equivalent to seven percent of the Spillway Design Flood - SDF - would cause the dam to be overtopped. (The SDF, in this instance, is one half of the Probable Maximum Flood). The decision to consider the spillway "inadequate" instead of "seriously inadequate" is based on the determination that dam failure from overtopping would not significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure. To ensure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Within three months of the consultant's findings, remedial measures to ensure spillway adequacy should be initiated.

b. Within six months from date of approval of this report, the following engineering studies and analyses should be initiated:

(1) Design a regrading of the embankment to remedy eroded areas and washouts.

(2) With the lake drawn down, inspect the concrete spillway and outlet works; formulate necessary repairs.

The owner should then perform the recommended remedial action. Additionally, all brush and trees on the embankment should be removed.

c. Within six months from the date of approval of this report, the owner should develop an emergency action plan outlining actions to be taken by the operator to minimize the downstream effects of an emergency and establish a flood warning system for the downstream communities.

d. Because of the observed embankment erosion a detailed topographic survey of the dam and area around the dam based on N.G.V.D. should be made within twelve months from the date of approval of this report. The survey map should be related to existing construction drawings and should become part of the permanent record.

e. Within one year from the date of approval of this report, the owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Patton of the Fifteenth District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Inspection Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

JAMES G. PON
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

Copies furnished:
Mr. Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

Mr. John O'Dowd, Acting Chief
Bureau of Flood Plain Regulation
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

GROVER'S MILL DAM (NJ00155)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 12 November 1979 by Storch Engineers under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Grover's Mill Dam, a high hazard potential structure, is judged to be in fair overall condition. The dam's spillway is considered inadequate because a flow equivalent to seven percent of the Spillway Design Flood - SDF - would cause the dam to be overtopped. (The SDF, in this instance, is one half of the Probable Maximum Flood). The decision to consider the spillway "inadequate" instead of "seriously inadequate" is based on the determination that dam failure from overtopping would not significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure. To ensure adequacy of the structure, the following actions, as a minimum, are recommended:

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(2) With the lake drawn down, inspect the concrete spillway and outlet works; formulate necessary repairs.

The owner should then perform the recommended remedial action. Additionally, all brush and trees on the embankment should be removed.

c. Within six months from the date of approval of this report, the owner should develop an emergency action plan outlining actions to be taken by the operator to minimize the downstream effects of an emergency and establish a flood warning system for the downstream communities.

d. Because of the observed embankment erosion a detailed topographic survey of the dam and area around the dam based on N.G.V.D. should be made within twelve months from the date of approval of this report. The survey map should be related to existing construction drawings and should become part of the permanent record.

e. Within one year from the date of approval of this report, the owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

APPROVED: James G. Ton

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 1 Jul 1980

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Grover's Mill Dam, NJ00155
State Located:	New Jersey
County Located:	Mercer
Drainage Basin:	Raritan River
Stream:	Big Bear Brook
Date of Inspection:	November 12, 1979

Assessment of General Condition of Dam

Based on visual inspection, past operational performance and Phase I engineering analyses, Grover's Mill Dam is assessed as being in fair overall condition.

Hydraulic and hydrologic analysis indicate that the spillway is inadequate. The discharge capacity of the spillway is not sufficient to pass the designated design flood (SDF) without an overtopping of the dam. (The SDF for Grover's Mill Dam is equal to one-half the probable maximum flood.) The spillway is capable of passing 3 percent of the probable maximum flood or 6 percent of the SDF. Therefore, the owner should, in the near future, engage a professional engineer experienced in the design and construction of dams to perform more accurate hydraulic and hydrologic analyses. Based on the findings of the analyses, the need for and type of remedial measures should be determined and then implemented.

The owner should, in the near future, develop an emergency action plan together with an effective warning system outlining actions to be taken by the operator to minimize downstream effects of an emergency at the dam.

Soil erosion and an inadequately filled washout were observed on the downstream face of the embankment. It is therefore recommended that a professional engineer experienced in the design and construction of dams be engaged in the near future to prepare a design for a regrading of the entire embankment and the embankment should be regraded accordingly.

In addition, it is recommended that the following remedial measures be undertaken by the owner in the near future.

1) Investigate and make functional the outlet works so that the lake can be lowered.
2) With the lake drawn down, the concrete spillway and outlet structure should be thoroughly inspected by a professional engineer experienced in the design and construction of dams. Based on the inspection, any necessary remedial measures should be determined and then implemented.
3) All adverse vegetation and trees on the embankment should be removed.

In the near future, the owner of the dam should develop written operating procedures and a periodic maintenance plan to insure the safety of the dam.

A detailed topographic survey of the dam and area around the dam based on N.G.V.D. should be undertaken by a qualified licensed land surveyor or professional engineer in the near future. The survey map should be related to existing construction drawings and should become part of the permanent record mentioned above.

Richard J. McDermott, P.E.

John E. Gribbin, P.E.

OVERVIEW - GROVER'S MILL DAM

29 NOVEMBER 1979

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that the unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PREFACE

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

GROVER'S MILL DAM, I.D. NJ00155

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

Public Law 92-367, August 8, 1972 authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The Division of Water Resources of the New Jersey Department of Environmental Protection (NJDEP) in cooperation with the Philadelphia District of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the State of New Jersey. Storch Engineers has been retained by the NJDEP to inspect and report on a selected group of these dams. The NJDEP is under agreement with the Philadelphia District of the Corps of Engineers.

b. Purpose of Inspection

The visual inspection of Grover's Mill Dam was made on November 12, 1979. The purpose of the inspection was to make a general assessment of the structural integrity and operational adequacy of the dam structure and its appurtenances.

1.2 Description of Project

a. Description of Dam and Appurtenances

Grover's Mill Dam is an earth dam with a horseshoe drop inlet spillway discharging through a concrete bridge located near the right end of the dam. The bridge abutments form the spillway discharge channel. Constructed for two-stage operation, the spillway consists of five concrete sections, each with a straight crest and inclined upstream face. The crest and upstream face are supported by a series of vertical walls or buttresses.

A paved public road is located on the dam crest for its entire length. A building formerly used as a mill is located on the downstream side of the dam at its right end. The outlet works consists of a 36-inch pipe discharging into a raceway adjacent to the former mill building. The outlet is controlled at the upstream end by stoplogs mounted on a concrete headwall. The downstream face of dam, between the outlet and the bridge, consists of a stone wall (adjacent to the outlet) and a concrete wall (adjacent to the bridge wingwall) with an earth slope between them.

The dam is oriented approximately north to south and has an overall length of 430 feet. The hydraulic height of the dam is 14.5 feet. The top width of the embankment is about 45 feet and downstream slope is 3 horizontal to 1 vertical. The elevation of the dam crest is 66.5 National Geodetic Vertical Datum (N.G.V.D.) while the elevations of the spillway crests are 64.7 (primary) and 65.0 (secondary).

b. Location

Grover's Mill Dam is located in West Windsor Township, Mercer County, New Jersey. Constructed across Big Bear Brook, the dam impounds Grover's Mill Pond. Principal access to the dam is by Clarksville Road which is located along its crest.

c. Size and Hazard Classification

Size and Hazard Classification criteria presented in "Recommended Guidelines for Safety Inspection of Dams," published by the U.S. Army Corps of Engineers are as follows:

SIZE CLASSIFICATION

	Impoundment	
	Storage (Ac-ft)	Height (Ft.)
Small	<1000 and ≥ 50	<40 and ≥ 25
Intermediate	≥ 1000 and $<50,000$	≥ 40 and <100
Large	$\geq 50,000$	≥ 100

HAZARD POTENTIAL CLASSIFICATION

Category	Loss of Life (Extent of Development)	Economic Loss (Extent of Development)
Low	None expected (no permanent structures for human habitation	Minimal (Undeveloped to to occasional structures or agriculture)
Significant	Few (No urban developments and no more than a small number of inhabitable structures	Appreciable (Notable agriculture, industry or structures)
High	More than a small number	Excessive (Extensive community, industry or agriculture)

The following data relating to size and downstream hazard for Grover's Mill Dam have been obtained for this Phase I assessment:

Storage: 237 Acre-feet

Height: 14.5 feet

Potential Loss of Life:

Several dwellings are located along the right bank of the downstream channel within 900 feet of the dam. A road bridge is located about 1700 feet from the dam. The former mill building, presently occupied by an office, is located on the downstream side of the dam at its right end. Failure of the dam could cause loss of more than a few lives.

Potential Economic Loss:

The former mill building could be destroyed as a result of dam failure and the other structures mentioned above could be damaged.

Therefore, Grover's Mill Dam is classified as "Small" size and "High" hazard potential.

d. Ownership

Grover's Mill Dam is owned by C. Laurence Dey, Princeton-Hightstown Road, Cranberry, N.J. 08512. The road on the dam crest and the bridge are owned by the County of Mercer, P.O. Box 8068, Trenton, N.J. 08625. The road right-of-way width is 60 feet.

e. Purpose of Dam

According to information in the NJDEP file, the dam was originally constructed for water power for a grist mill. The dam presently impounds a lake used for recreation.

f. Design and Construction History

According to information in the NJDEP file, Grover's Mill Dam was constructed in 1931 by the owner C. Laurence Dey. It was designed by Sincerbeaux & Moore of New Brunswick, N.J.

Construction commenced in August 1931 and was completed in November of the same year. Seven inspection reports are available in the NJDEP file. In these inspection reports, the foundation was described as yellow clay from elev. 45 (N.G.V.D.) to 51 (N.G.V.D.). Sheet piles originally designed as a cutoff wall were determined by the State of New Jersey to be unnecessary and were not installed. Final inspection by the State of New Jersey indicated that the dam was properly constructed.

g. Normal Operational Procedures

It is not known if any maintenance is performed by the owner. Reportedly, the lake has not been lowered since the mill discontinued operation.

1.3 Pertinent Data

a. Drainage Area — 12.3 sq. miles

b. Discharge at Damsite

Maximum flood at damsite	Unknown
Outlet works at normal pool	61 c.f.s.
Spillway capacity at top of dam (Elev. 66.5)	482 c.f.s.

c. Elevation (N.G.V.D.)

Top of dam	Varies: 66.5 to 67.6
Maximum pool-design surcharge	69.2
Normal pool	65.1
Spillway crest - Primary	64.7
Secondary	65.0
Stream bed at centerline of dam	53.1
Maximum tailwater	57 (Estimated)

d. Reservoir

Length of maximum pool	1750 feet
Length of normal pool	1350 feet

e. Storage (Acre-feet)

Spillway crest	150 acre-feet
Design surcharge	410 acre-feet
Top of dam (Elev. 66.5)	237 acre-feet

f. Reservoir Surface (Acres)

Spillway crest	45 acres
Top of dam (Elev. 66.5)	53 acres
Maximum pool - design surcharge	76 acres

g. Dam

Type	Earthfill
Length	430 feet
Hydraulic height	14.5 feet

	Side slopes	
	Embankment - Upstream	1.5 horiz. to 1 vert. (according to NJDEP file)
	Downstream	3 horiz. to 1 vert.
	Zoning	Unknown
	Impervious core	Unknown
	Cutoff	Unknown
	Grout curtain	Unknown
h.	Diversion and Regulating Tunnel	N.A.
i.	Spillway	
	Type	Uncontrolled concrete weir
	Length of weir - Primary	24 feet
	- Secondary	39 feet
	Crest elevation - Primary	64.7
	- Secondary	65.0
	Gates	N.A.
	Approach channel	N.A.
	Downstream channel	Natural stream
j.	Regulating outlets	

36-inch RCP controlled by stoplogs at upstream end.

SECTION 2: ENGINEERING DATA

2.1 Design

Design calculations and plans pertaining to the design of the dam by Sincerbeaux & Moore, Civil Engineers, New Brunswick, N.J. are available in NJDEP files.

2.2 Construction

In addition to design drawings prepared by Sincerbeaux & Moore as described in 2.1 above, reports of site inspections made during construction are available in NJDEP files. The reports indicate that construction was acceptable to the State of New Jersey.

2.3 Operation

No records of operation and maintenance of the dam subsequent to construction are available.

One inspection report in 1971 by Thomas Tyler Moore, P.E. indicates minor concrete spalling at spillway crest and a man-made hole in one of the spillway cells. Permanent repairs to the hole, possibly incorporating a low level outlet device, were recommended. It was indicated in the same report that dam was overtopped by 2.1 feet in 1971. No evidence of the hole was observed at the time of the present inspection.

According to the Mercer County Maintenance Department concrete rubble was used to stabilize the eroded surface on the downstream side of the embankment.

2.4 Evaluation

a. Availability

Available engineering information is limited to that which is on file at the New Jersey Department of Environmental Protection (NJDEP), Division of Water Resources, P.O. Box CN-029, Trenton, N.J. 08625. Information includes correspondence, construction applications, inspection reports, construction plans and design computations.

b. Adequacy

Available engineering data pertaining to Grover's Mill Dam is of limited assistance to the performance of a Phase I evaluation. A list of absent information is included in paragraph 7.1.b.

c. Validity

In general, information that could be verified was found to be valid within a reasonable allowance for error. However, some discrepancies were noted. The size of the outlet works pipe was measured to be 36 inches; less than 42 inches as shown on the application. Riprap shown on the plan on the upstream side of the dam was not observed in the field.

The design computations contained in the NJDEP file were too sketchy to be analyzed for validity.

SECTION 3: VISUAL INSPECTION

3.1 *Findings*

a. General

The inspection of Grover's Mill Dam took place on November 12, 1979 by members of the staff of Storch Engineers. A copy of the visual inspection check list is contained in Appendix 1. The following procedures were employed for the inspection:

1) The embankment of the dam, appurtenant structures and adjacent areas were examined.
2) The embankment and appurtenant structures were measured and key elevations determined by surveyor's level.
3) The embankment and appurtenant structures and adjacent areas were photographed.
4) Depths of water were measured at various locations in the lake.

b. Spillway

The concrete forming the horseshoe spillway appeared to be structurally sound although some erosion was observed at the crest resulting in exposed aggregate. The weir portion of the spillway was partially obscured by overflow at the time of the inspection.

c. Embankment

The upstream and downstream slopes of the embankment were generally covered with trees and bushes. On the downstream slope, areas adjacent to the bridge wingwalls have been

considerably eroded due to surface runoff and high tailwater. Evidence of a partial embankment washout adjacent to the right wingwall was noted. The washout had been filled with concrete rubble.

The stone wall adjacent to the mill race was deteriorated, with some stones dislodged.

d. Bridge

The bridge is Mercer County Bridge No. 762.2 built in 1931. The condition of the concrete comprising the bridge and discharge channel under the bridge appeared to be in fair condition. The concrete surfaces exhibited moderate deterioration with some cracks, spalls and leaching noted. The downstream wingwalls appeared to be in poor condition. The surfaces were generally sound with cracking and severe spalling at the downstream ends. The concrete wall adjacent to the right wingwall was tilted in the downstream direction.

e. Reservoir Area

Grover's Mill Pond is bordered by wooded areas and paved roads on the north side. Upstream from the reservoir are wetlands which normally become inundated during heavy storms. A few dwellings, some with docks, are located along the west shore.

f. Downstream Channel

The downstream channel consists of a natural stream with a wide stilling basin at the dam and generally swampy banks farther downstream. The stream is called the Big Bear Brook and is a tributary of the Millstone River. Several dwellings are located along the right bank within 900 feet of the dam and lie approximately 5 to 7 feet above the stream bed. A public road bridge is located about 1700 feet from the dam.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

The level of water in Grover's Mill Pond is regulated naturally by discharge over the two-stage spillway. The outlet is not reported to be used during times of intense storms to augment the spillway capacity.

4.2 Maintenance of the Dam

Maintenance within the right of way of Clarksville Road is performed by the Mercer County Highway Department. No maintenance is known to have been performed on the embankment.

4.3 Maintenance of Operating Facilities

It is not known if any maintenance is performed on the operating facilities.

4.4 Description of Warning System

No formal warning system is in use at the present time.

4.5 Evaluation of Operational Adequacy

Maintenance documentation is poor and if a maintenance program exists for the dam, the following areas appear to be insufficient:

1) Trees and brush on embankment.
2) Downstream embankment slope eroded by high tailwater and previous overtopping.

3) Outlet works reportedly not functioning.

4) Partial washout adjacent to right downstream wingwall not properly repaired.

5) Stone wall on downstream face of dam in deteriorated condition.

6) Concrete wall adjacent to right downstream wingwall tilting.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data

The quantity of storm water runoff that the spillway should be able to pass without an overtopping of the dam is based on the size and hazard classification of the dam. This runoff, called the Spillway Design Flood (SDF), is described in terms of frequency or probable maximum flood (PMF) depending on the extent of the dam's size and potential hazard. According to the "Recommended Guidelines for Safety Inspection of Dams, " published by the U.S. Army Corps of Engineers, the SDF for Grover's Mill Dam falls in a range of 1/2 PMF to PMF. In this case the low end of the range, 1/2 PMF, is chosen since the factors used to select size and hazard classification are on the low side of their respective ranges.

The SDF hydrograph for Grover's Mill Dam was computed by use of the HEC-1-DB computer program using the Snyder's snythetic hydrograph. Hydrologic computations and computer output are contained in Appendix 4. The calculated SDF peak inflow for Grover's Mill is 7271 c.f.s.

Discharge capacity for the spillway was computed by considering free discharge over the spillway. Hydraulic computations are contained in Appendix 4.

A routing of the SDF through Grover's Mill Dam resulted in an overtopping of the dam by a depth of 2.7 feet. Dam failure resulting from overtopping would not significantly increase the hazard to loss of life downstream over that which would exist without failure. Accordingly, the subject spillway is assessed as being inadequate in accordance with criteria developed by the U.S. Army Corps of Engineers.

b. Experience Data

Reportedly, the dam was overtopped in 1971 by as much as 2 feet. Also, the dam was reportedly overtopped in August 1975 at which time downstream homes were inundated but sustained no structural damage.

c. Visual Observations

The downstream slope of the embankment was observed to be previously eroded and partially washed out. Trees on the embankment have their roots exposed due to high tail water and surface erosion. Visual evidence indicated that dam has been overtopped.

d. Overtopping Potential

As indicated in paragraph 5.1.a., a storm of magnitude equivalent to the SDF would cause overtopping by a depth of 2.7 feet over the top of the dam. The spillway is capable of passing approximately 7 percent of the PMF and 14 percent of the SDF with lake level equal to the top of the dam (elev. 66.5).

e. Drawdown Data

Reportedly, the lake has not been drawn down since the mill discontinued operation. If drawdown through the 36-inch pipe is possible, the time needed to lower the lake is estimated to be approximately 5 days.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observation

The dam appeared at the time of inspection to be outwardly stable. Erosion and a partial washout were observed on the embankment. A vertical crack observed in the right downstream wingwall could be due to settlement of the downstream end of the wingwall caused by undermining.

b. Generalized Soils Description

The generalized soils description of the dam site consists of recent alluvium, composed of stratified materials deposited by streams, overlying a discontinuous mantle of stratified, alluvial material deposited during the Quaternary period, known as the Cape May Formation. The Quaternary deposits consist of sand, silty sand and sandy silt. The underlying formations are consolidated Cretaceous sediments known as Magothy and Raritan Formations.

c. Design and Construction Data

Structural stability analyses for the dam are not available.

d. Operating Records

One inspection report by Thomas Tyler Moore, P.E. in 1971 indicated "minor concrete spalling at lip of spillway. No apparent structural damage" and a man-made hole approximately 4.5' X 3' in first southerly cell. Apparently, the man-made hole had been subsequently repaired. Minor erosion on the spillway lip, or crest, can presently be observed.

e. Post Construction Changes

No records of any post construction changes are available.

f. Seismic Stability

Grover's Mill Dam is located in Seismic Zone 1 as defined in "Recommended Guideline for Safety Inspection of Dams," which is a zone of very low seismic activity. Experience indicates that dams in Seismic Zone 1 will have adequate stability under seismic loading conditions if stable under static loading conditions. Grover's Mill Dam appeared to be stable under static loading conditions.

SECTION 7: ASSESSMENT AND RECOMMENDATIONS

7.1 Dam Assessment

a. Safety

Based on hydraulic and hydrologic analyses outlined in Section 5 and Appendix 4, the spillway of Grover's Mill Dam is assessed as being inadequate.

The dam appeared, at the time of inspection, to be generally outwardly stable. An inadequately filled partial washout adjacent to the right downstream wingwall of the bridge was observed.

b. Adequacy of Information

Information sources for this study include: 1) field inspection, 2) USGS quadrangle, 3) aerial photography supplied by Mercer County, 4) plans, correspondence and inspection reports in the NJDEP file and 5) aerial topograhy supplied by the Township of West Windsor. The information obtained is sufficient to allow a Phase I assessment as outlined in "Recommended Guidelines for Safety Inspection of Dams."

Some of the absent data are as follows:

1) Stream and lake elevation gaging records.
2) Structural and Hydraulic Design reports.
3) Maintenance documentation.
4) Soils report.

c. Necessity for Additional Data/Evaluation

Although some data pertaining to Grover's Mill Dam are not available, additional data are not considered imperative for this Phase I evaluation.

7.2 Recommendations

a. Remedial Measures

Based on hydraulic and hydrologic analyses outlined in paragraph 5.1.a., the spillway is assessed as being inadequate. It is therefore recommended that a professional engineer experienced in the design and construction of dams be engaged in the near future to perform more accurate hydraulic and hydrologic analyses. Based on the findings of these analyses the need for and type of remedial measures should be determined and then implemented.

The owner should in the near future develop an emergency action plan together with an effective warning system outlining actions to be taken by the operator to minimize downstream effects of an emergency at the dam.

Soil erosion and an inadequately filled washout were observed on the downstream slope of the embankment. It is therefore recommended that a professional engineer experienced in the design and construction of dams be engaged in the near future to prepare a design for a regrading of the entire embankment and the embankment should be regraded accordingly.

In addition, it is recommended that the following remedial measures be undertaken by the owner in the near future.

1) Investigate and make functional the outlet works so that the lake can be lowered.

2) With the lake drawn down, the concrete spillway and outlet structure should be thoroughly inspected by a professional engineer experienced in the design and construction of dams. Based on the inspection, any necessary remedial measures should be determined and then implemented.

3) All adverse vegetation and trees on the embankment should be removed.

b. Maintenance

In the near future, the owner of the dam should develop written operating procedures and a periodic maintenance plan to insure the safety of the dam.

c. Additional Studies

A detailed topographic survey of the dam and area around the dam based on N.G.V.D. should be undertaken by a qualified licensed land surveyor or professional engineer in the near future. The survey map should be related to existing construction drawings and should become part of the permanent record mentioned in paragraph 7.2.b.

PLATES

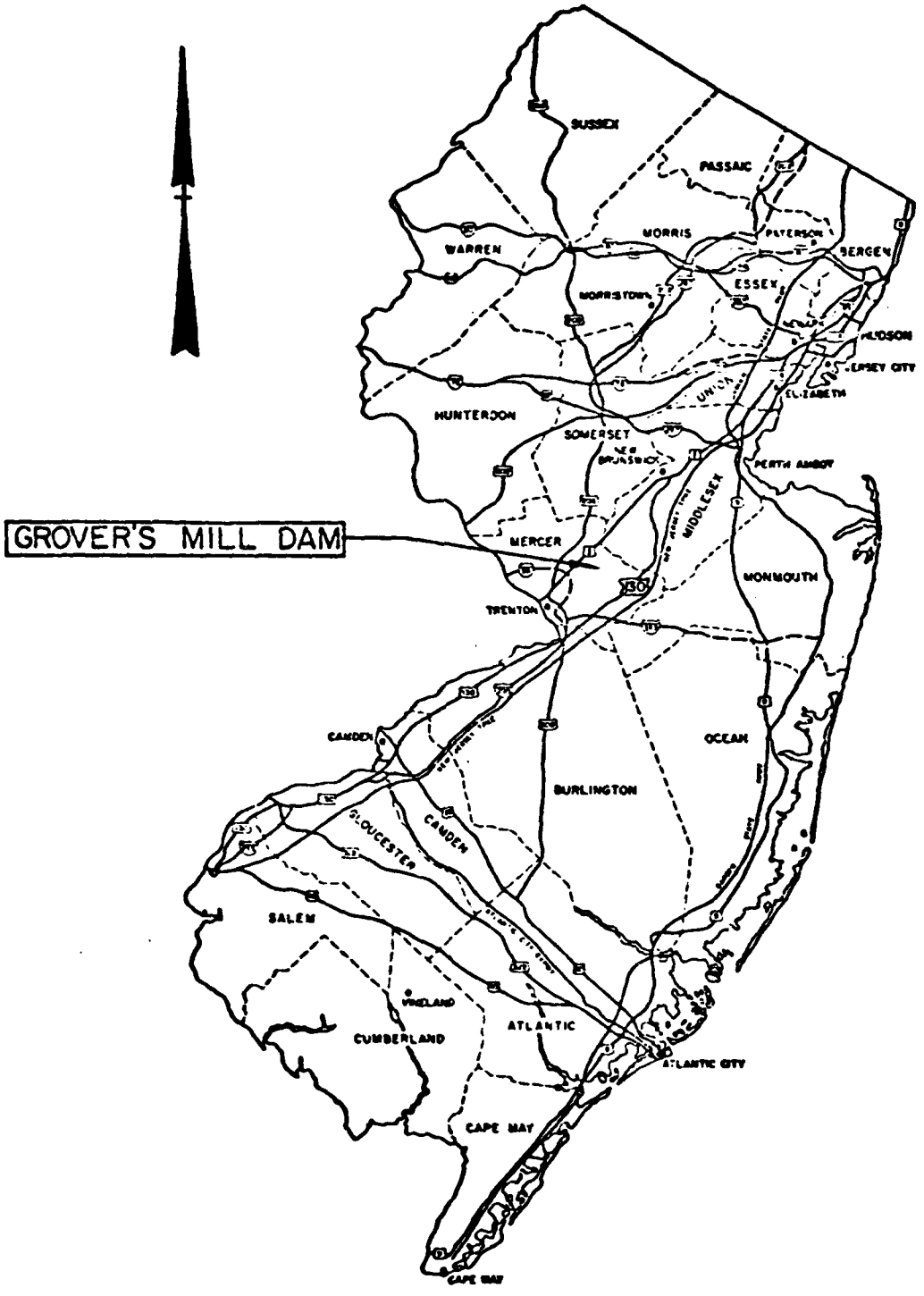
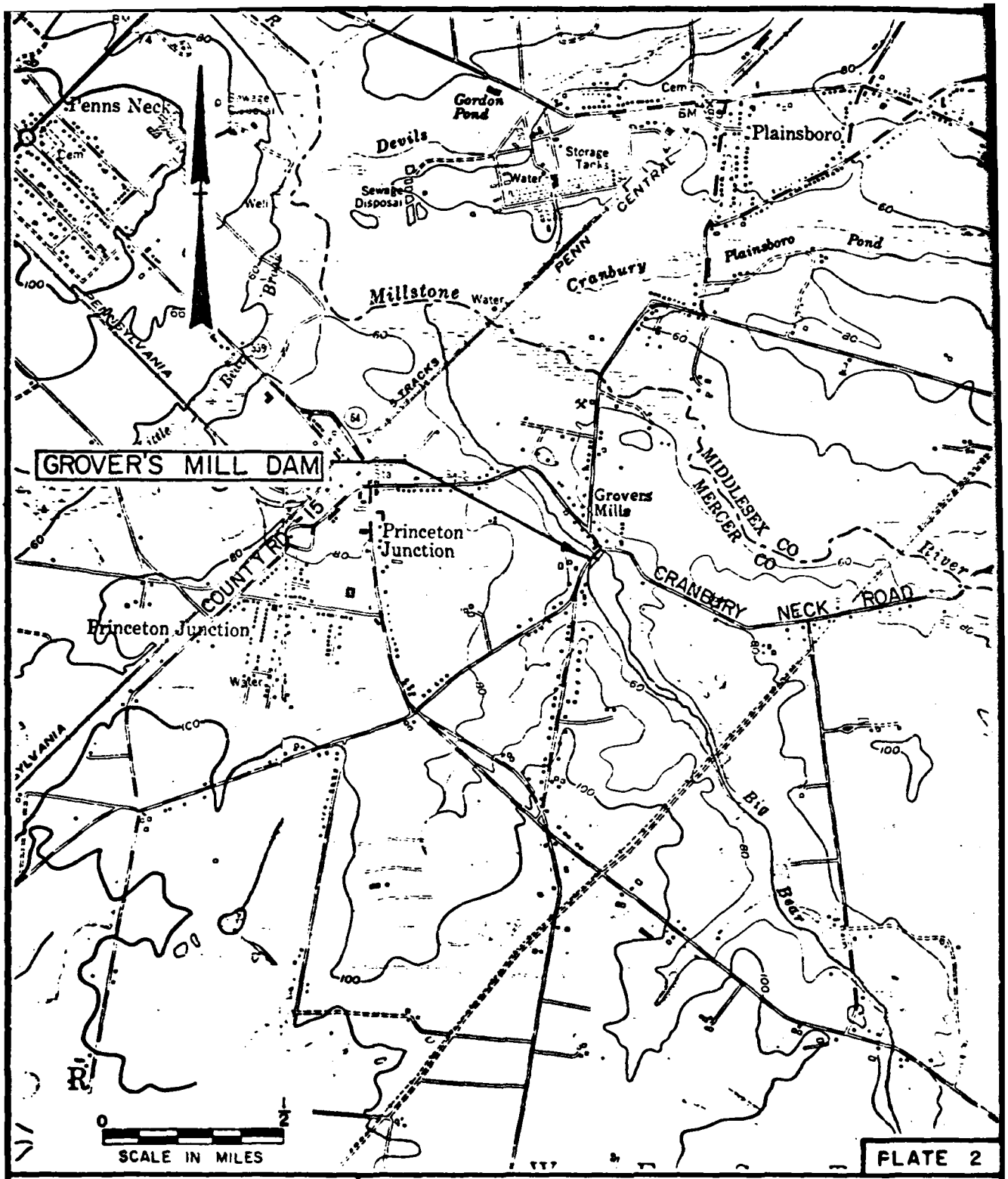


PLATE 1

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	INSPECTION AND EVALUATION OF DAMS KEY MAP GROVER'S MILL DAM
DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY	I.D.N.J. 00155 — SCALE: NONE DATE: NOV., 1979



STORCH ENGINEERS
FLORHAM PARK, NEW JERSEY

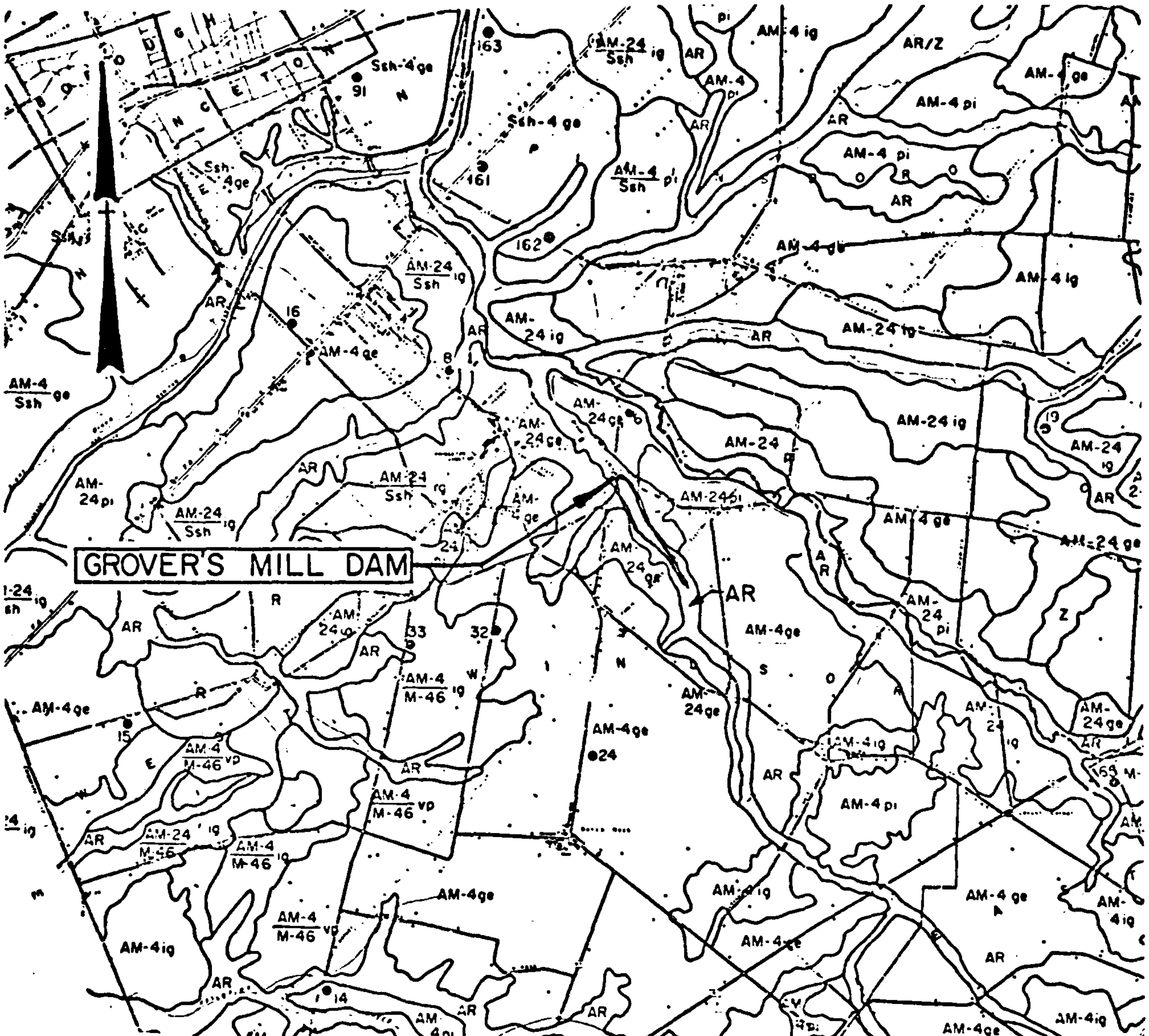
DIVISION OF WATER RESOURCES
N.J. DEPT. OF ENVIR. PROTECTION
TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

VICINITY MAP

GROVER'S MILL DAM

I. D. N.J. 00155	SCALE: AS SHOWN
	DATE: NOV., 1979

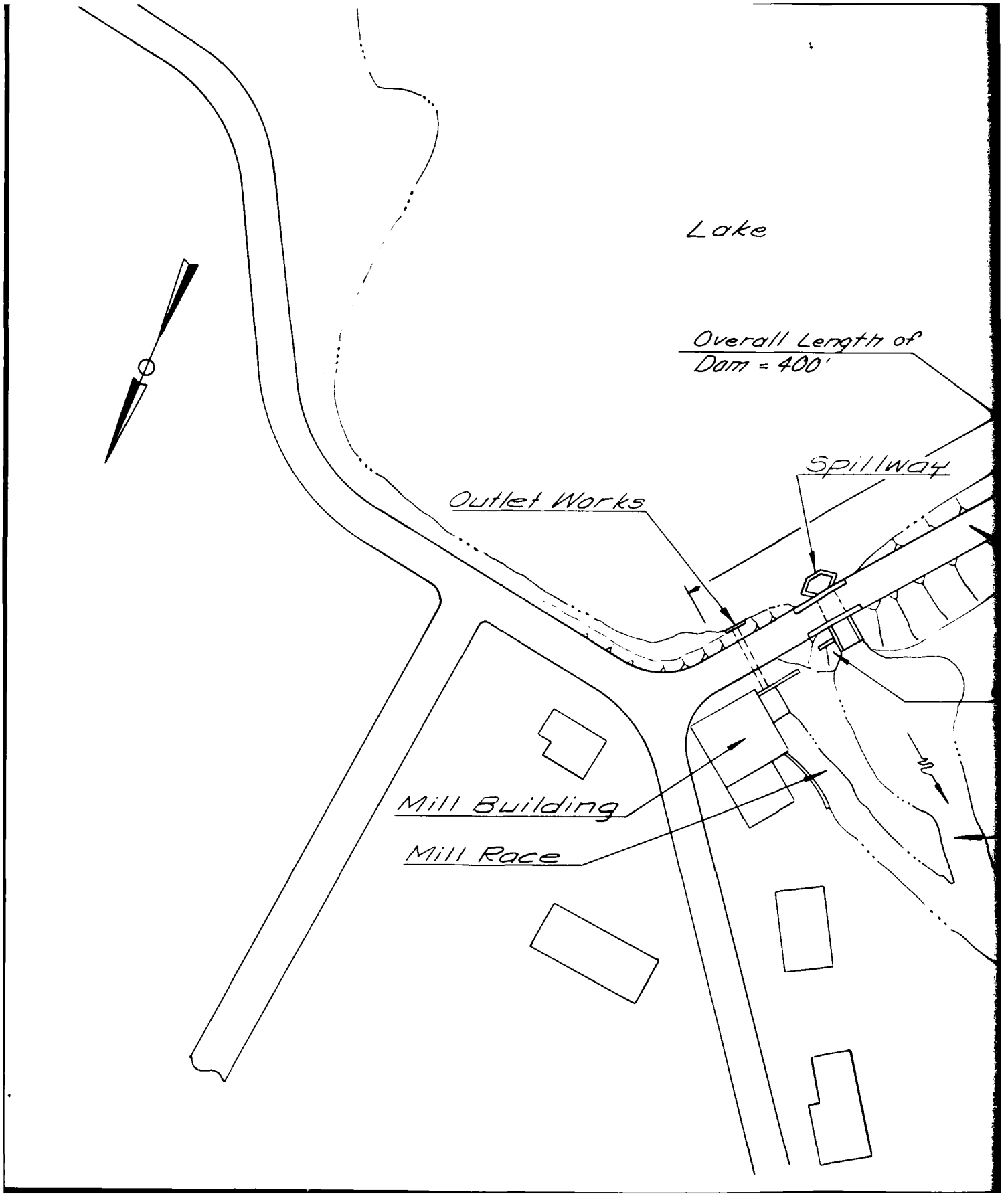


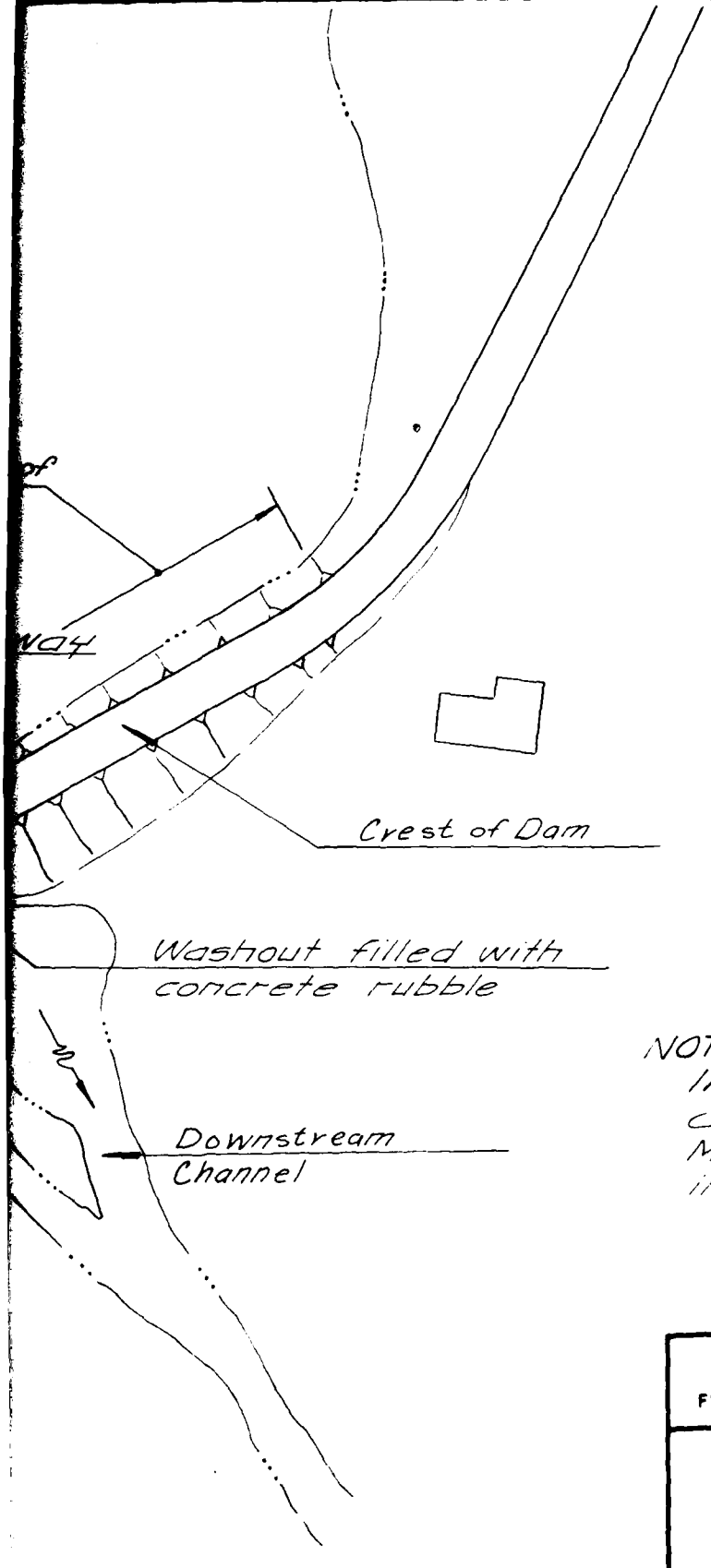
Legend

AR	Recent alluvium composed of stratified materials deposited by streams.
AM-24	Sand, silty sand and sandy silt deposited during the Quaternary period (Cape May Formation).
NOTE:	Information taken from Rutgers University Soil Survey of New Jersey, Report No. 12, Mercer County, and Geological Map of New Jersey prepared by Lewis and Kummel.

PLATE 3

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	INSPECTION AND EVALUATION OF DAMS **SOIL MAP** GROVER'S MILL DAM
DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY	I.D. NJ 00155 — SCALE: NONE DATE: NOV., 1979


Lake
Overall Length of Dam = 400'
Spillway
Outlet Works
Mill Building
Mill Race



NOTE:
Information taken from aerial photographs of Mercer County and field inspection November 12, 1979.

PLATE 4

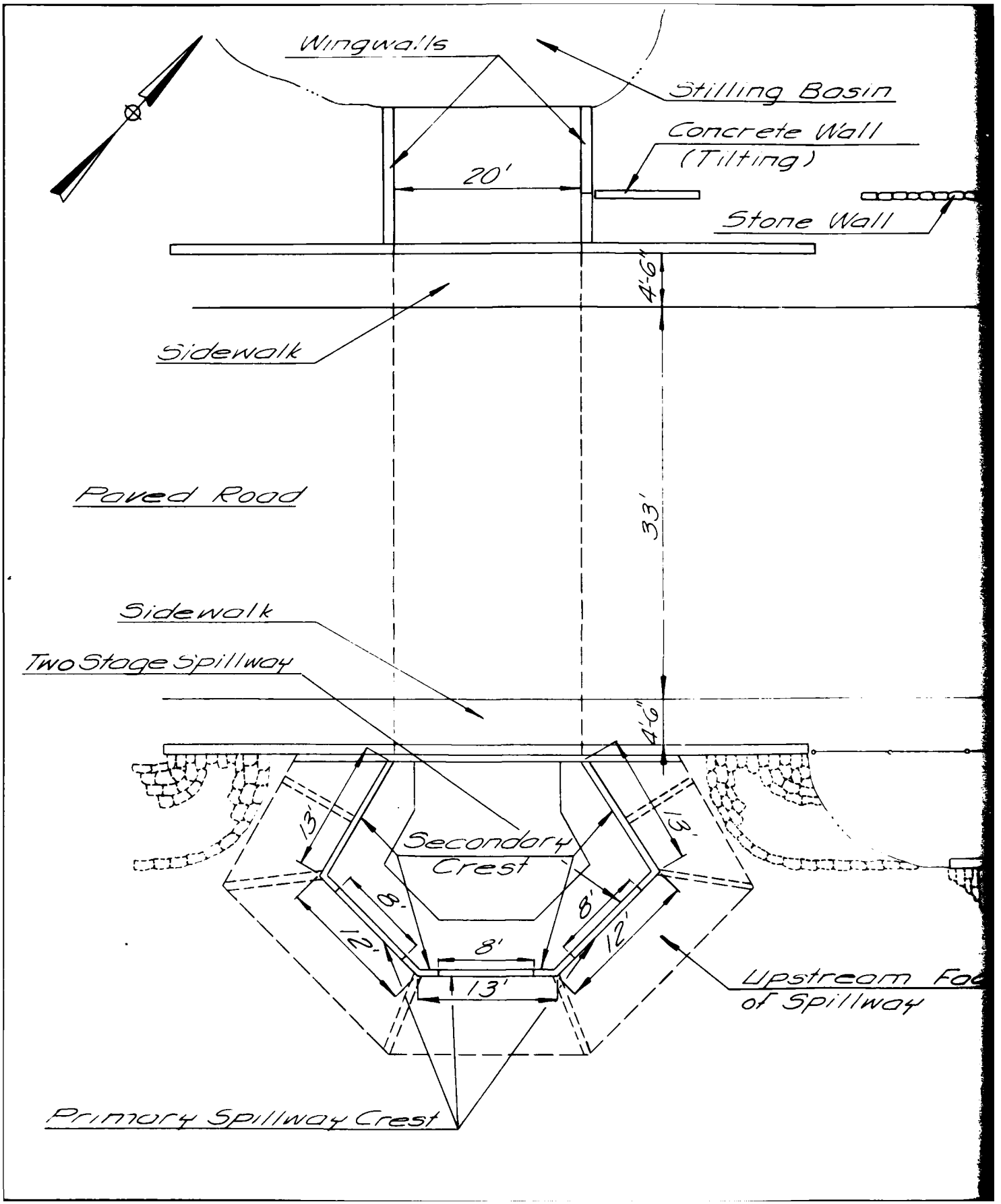
STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY

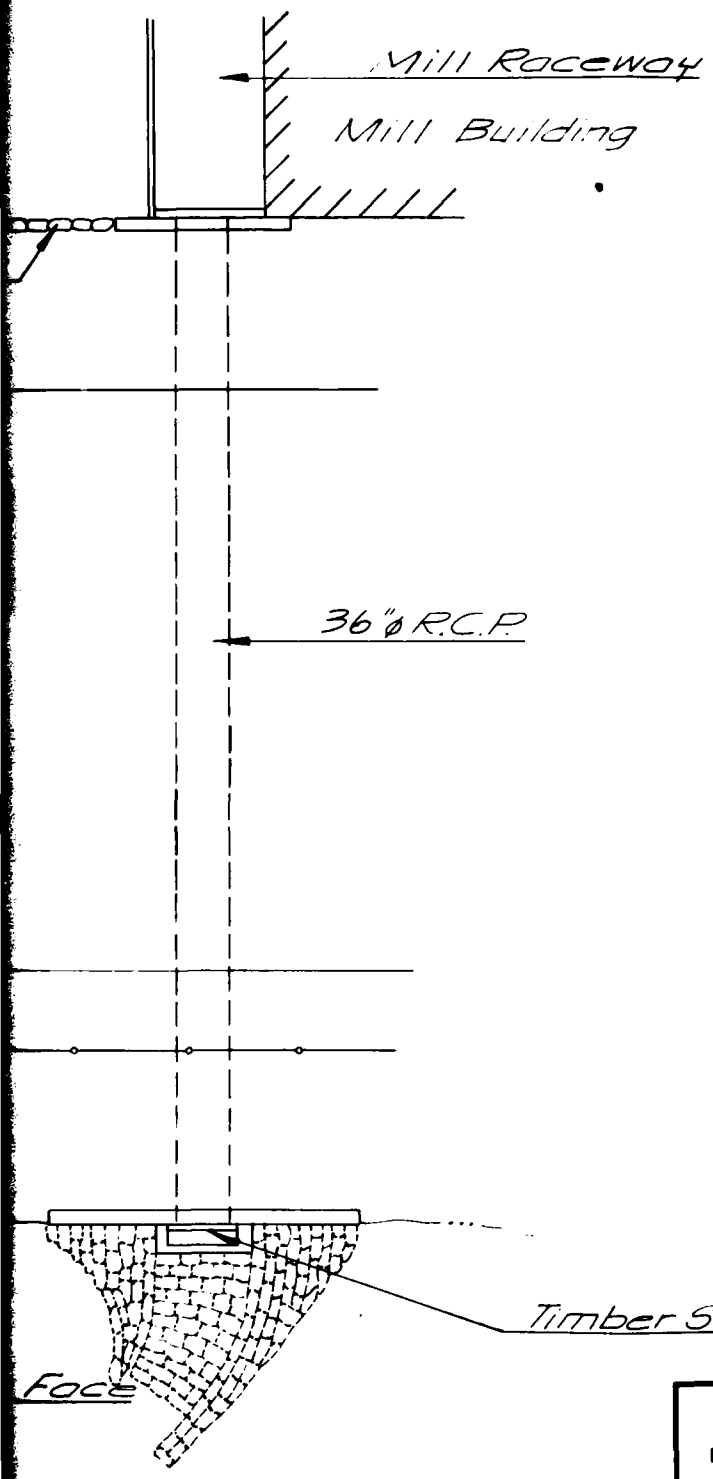
INSPECTION AND EVALUATION OF DAMS

GENERAL PLAN

GROVER'S MILL DAM

I.D. N.J. 00155	SCALE: NOT TO SCALE
	DATE: DEC., 1979


Wingwalls
Stilling Basin
Concrete Wall
(Tilting)
20'
Stone Wall
4'-6"
Sidewalk
Paved Road
33'
Sidewalk
Two Stage Spillway
4'6"
13'
Secondary
Crest
13'
8'
8'
12'
8'
12'
13'
Upstream Fac
of Spillway
Primary Spillway Crest



NOTE:
Information taken from "Construction Plan of Proposed Grover's Mill Dam" by Sincerbeaux, Moore & Sinn and field inspection November 12, 1979

PLATE 5

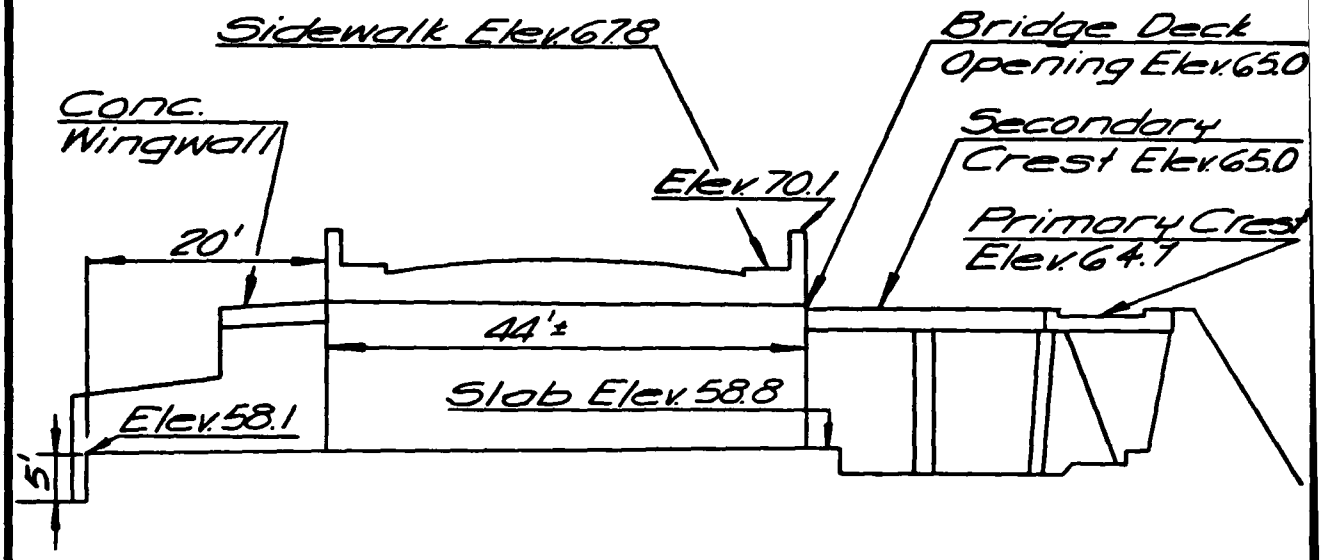
STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

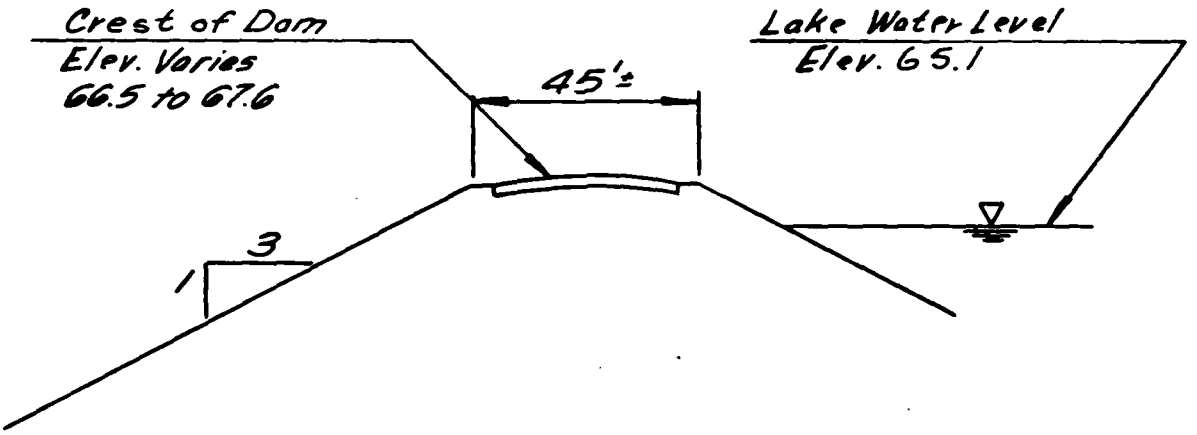
SPILLWAY PLAN

GROVER'S MILL DAM

I.D.N.J. 00155	SCALE: NOT TO SCALE
	DATE:



SPILLWAY SECTION



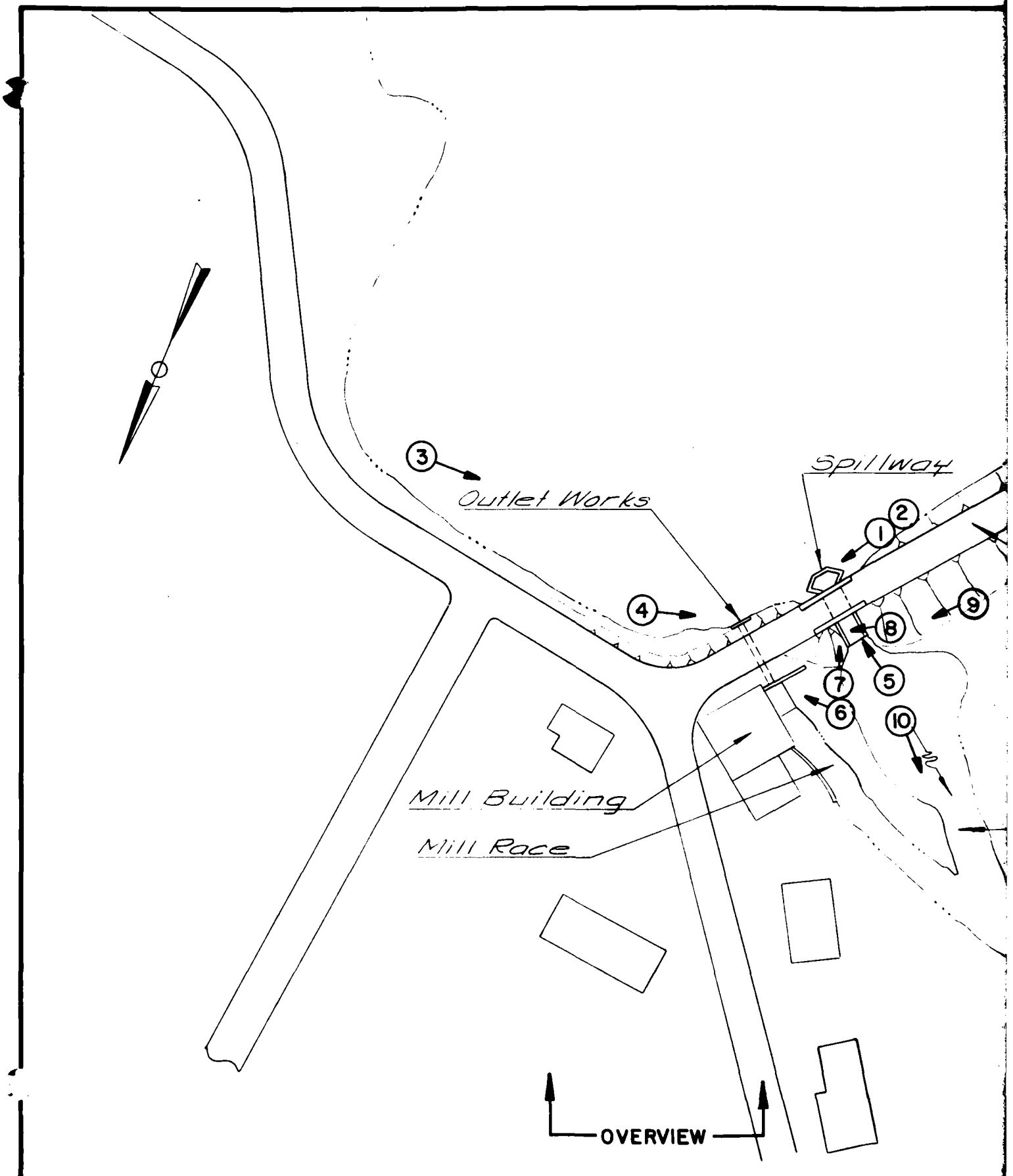
DAM SECTION

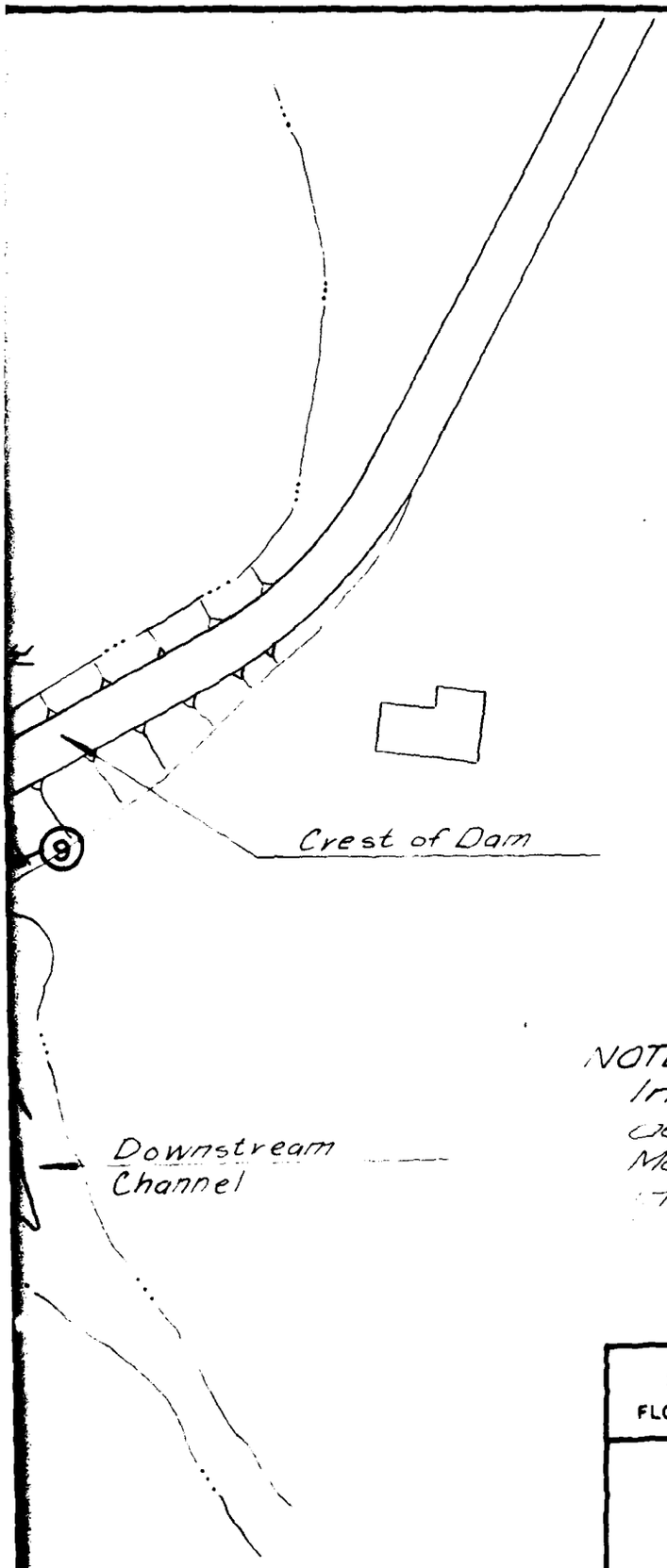
Notes:

1. Information taken from "Construction Plan of Proposed Grovers Mill Dam" by Sincerbeaux, Moore & Sinn and field inspection November 12, 1979
2. Elevations based on N.G.V.D. taken from plans by Sincerbeaux, Moore & Sinn.

PLATE 6

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	INSPECTION AND EVALUATION OF DAMS DAM SECTIONS GROVER'S MILL DAM
DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY	I.D.N.J. 00155 — SCALE: NOT TO SCALE DATE:


3
Outlet Works
Spillway
2
1
4
9
8
7
5
6
10
Mill Building
Mill Race
OVERVIEW



NOTE:
Information taken from aerial photographs of Mercer County and field inspection November 12, 1979.

PLATE 7

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

PHOTO LOCATION PLAN

GROVER'S MILL DAM

I.D. N.J. 00155	SCALE: NOT TO SCALE
	DATE: DEC., 1979

APPENDIX 1

Check List - Visual Inspection

Check List - Engineering Data

Check List
Visual Inspection
Phase I

Name of Dam Grover's Mill Dam County Mercer State New Jersey Coordinators NJDEP

Date(s) Inspection 11/12/79 Weather Cloudy Temperature 45°F

Pool Elevation at Time of Inspection 65.1 M.S.L. Tailwater at Time of Inspection 58.1 M.S.L.

Inspection Personnel:

John Gribbin	Alan Volle	
Ronald Lai	Thomas Miller	
Richard McDermott		

J. Gribbin Recorder

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
GENERAL	Embankment generally covered with trees and brush. Paved public road located on crest along entire length of dam.	Recommend removal of trees and brush.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Evidence of embankment washout adjacent to right downstream wingwall. Washout filled with concrete rubble.	Recommend regrading of downstream face of embankment
ANY NOTICEABLE SEEPAGE	None observed	
STAFF GAGE AND RECORDER	None observed	
DRAINS	None observed	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	Cracks and deterioration observed in paved road on crest - did not appear to be evidence of embankment distress.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	No sloughing observed. Significant erosion of downstream face observed in vicinity of stilling basin.	Recommend regrading of embankment.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Vertical: generally level Horizontal: straight	
RIPRAP FAILURES	No riprap observed on upstream face. Stone wall on downstream side, adjacent to mill race deteriorated with some stones dislodged.	Riprap slope protection indicated on available construction drawings.

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SURFACES IN OUTLET CONDUIT	Could not be observed.	
INTAKE STRUCTURE	Concrete headwall in generally satisfactory condition. Upper end of steel rails for stoplogs appeared to be in generally satisfactory condition.	Intake consists of stoplogs mounted on concrete headwall.
OUTLET STRUCTURE	Outlet pipe discharges into mill race enclosed by concrete and timber wall. Outlet inaccessible and not observed.	
OUTLET CHANNEL	Generally earth lined ditch with mill building and stone wall along right side.	Outlet channel consists of mill race.
GATE AND GATE HOUSING	Stoplogs at upstream end submerged and not observed.	Recommend investigation of outlet works to make functional.

SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONC. WEIR	Concrete surfaces appeared to be in generally satisfactory condition with some exposed aggregate. Structure appeared outwardly sound.	Weir partially obscured by overflow.
DISCHARGE CHANNEL	Concrete surfaces appeared to be in fair condition with some cracks and spalls noted.	Channel formed by concrete bridge abutments.
WINGWALLS	Downstream wingwalls appeared to be in poor condition. Surfaces were generally sound with severe spalling at the downstream ends. A few cracks were observed and the concrete wall adjacent to the right wingwall was tilted in the downstream direction.	
BRIDGE	The concrete bridge appeared to be in fair condition. It appeared to be generally structurally sound. The concrete surfaces exhibited moderate deterioration with some cracks, spalls and leaching noted.	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None observed	
OBSERVATION WELLS	None observed	
WEIRS	None observed	
PIEZOMETERS	None observed	
OTHER	N.A.	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Shores are generally wooded with average slope of approx. 30 horiz. to 1 vert.	
SEDIMENTATION	Soundings in the lake in the vicinity of the spillway indicated little accumulation of sediment.	
STRUCTURES ALONG BANKS	A paved road is located along a portion of the east. shore. A few dwellings, some with docks, are located along the west shore.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Downstream channel consists of natural stream with wide stilling basin at dam and generally swampy banks farther downstream. Banks are generally wooded with some grassed areas on the right about 300 feet from the dam.	
SLOPES	Slopes are generally flat within 250 feet of stream and approx. 5 horiz. to 1 vert. beyond.	
STRUCTURES ALONG BANKS	Several dwellings are located along the right bank within 900 feet of the dam. A road bridge is located about 1700 feet from the dam.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
DAM - PLAN	Construction drawing titled "Construction Plan of Proposed Grover's Mill Dam of Charles L. Dey" by Sincerbeaux, Moore & Shinn, dated May 1931. (NJDEP file)
SECTIONS	
SPILLWAY - PLAN	Plans, sections and details available - see Sincerbeaux drawing above.
SECTIONS	
DETAILS	
OPERATING EQUIPMENT PLANS & DETAILS	N.A.
OUTLETS - PLAN	Plans of outlet works on Sincerbeaux drawing
DETAILS	
CONSTRAINTS	
DISCHARGE RATINGS	
HYDRAULIC/HYDROLOGIC DATA	Not available
RAINFALL/RESERVOIR RECORDS	Not available
CONSTRUCTION HISTORY	Available - correspondence and inspection reports in NJDEP file
LOCATION MAP	Sincerbeaux drawing.

ITEM	REMARKS
DESIGN REPORTS	Not available
GEOLOGY REPORTS	Not available
DESIGN COMPUTATIONS	
HYDROLOGY & HYDRAULICS	Available - NJDEP file
DAM STABILITY	Available - NJDEP file
SEEPAGE STUDIES	Not available
MATERIALS INVESTIGATIONS	Not available
BORING RECORDS	
LABORATORY	
FIELD	
POST-CONSTRUCTION SURVEYS OF DAM	Not available
BORROW SOURCES	Not available

ITEM	REMARKS
MONITORING SYSTEMS	Not available
MODIFICATIONS	Plans for dam and spillway reconstruction - Sincerbeaux drawing, dated 1931.
HIGH POOL RECORDS	Reference to overtopping depth of 2.1 feet in inspection report in NJDEP file.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Not available
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	Inspection reports and correspondence in NJDEP file
MAINTENANCE OPERATION RECORDS	Not available

APPENDIX 2

Photographs

12 NOVEMBER 1979

PHOTO 1

SPILLWAY

28 NOVEMBER 1979

PHOTO 2

SPILLWAY - FLOW OVER PRIMARY CRESTS ONLY

GROVER'S MILL DAM

29 NOVEMBER 1979

PHOTO 3

CREST AND UPSTREAM FACE OF DAM

12 NOVEMBER 1979

PHOTO 4

HEADWALL AT OUTLET WORKS INTAKE

GROVER'S MILL DAM

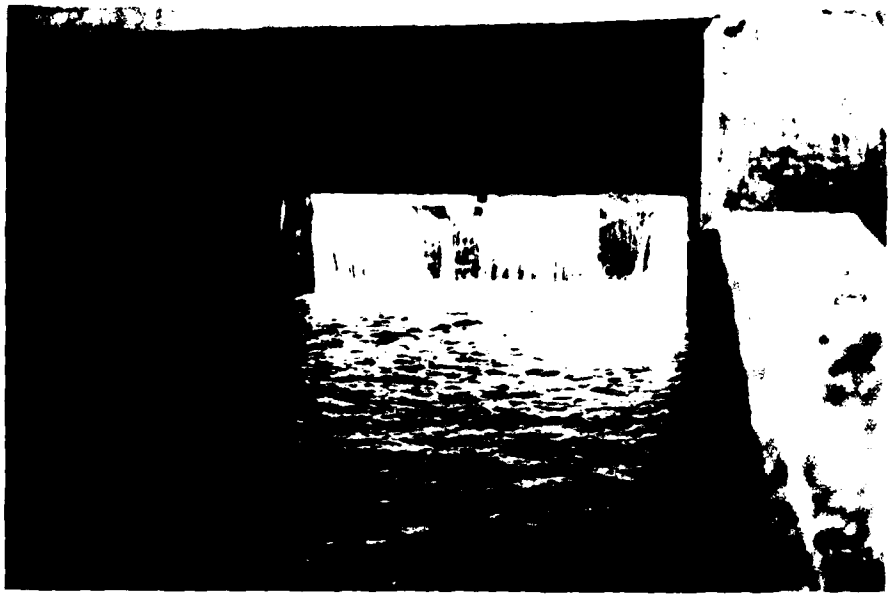


PHOTO 5

SPILLWAY DISCHARGE CHANNEL FORMED BY BRIDGE ABUTMENTS

PHOTO 6

MASONRY WALL ADJACENT TO MILL RACE

GROVER'S MILL DAM
12 NOVEMBER 1979

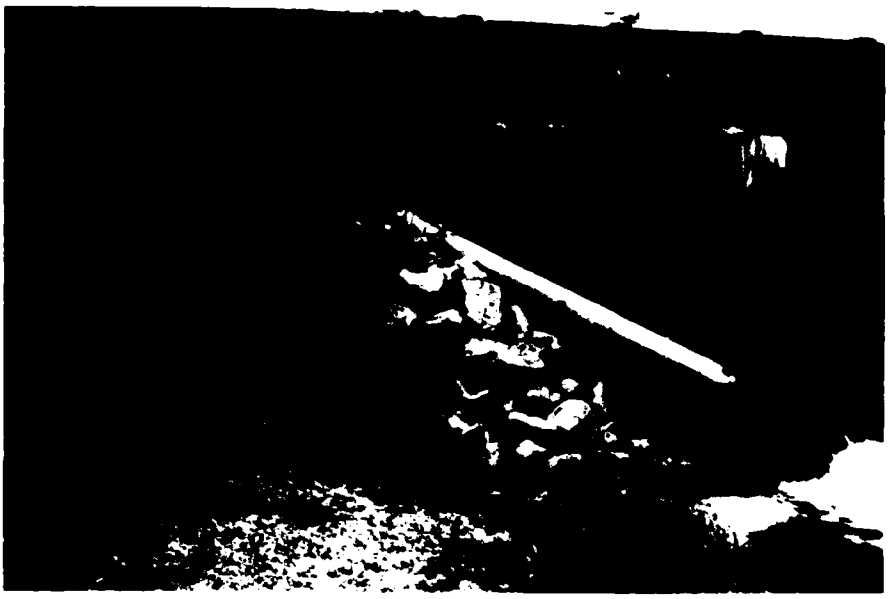


PHOTO 7

SPILLWAY DISCHARGE CHANNEL OUTLET WITH DUMPED FILL ADJACENT TO WINGWALL

PHOTO 8

DUMPED FILL ADJACENT TO WINGWALL

GROVER'S MILL DAM
12 NOVEMBER 1979

PHOTO 9

DOWNSTREAM FACE OF DAM

PHOTO 10

DOWNSTREAM CHANNEL

GROVER'S MILL DAM
12 NOVEMBER 1979

APPENDIX 3

Engineering Data

CHECK LIST

HYDROLOGIC AND HYDRAULIC DATA

ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Predominantly wooded

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 65.1 (166 Ac-ft)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): N.A.

ELEVATION MAXIMUM DESIGN POOL: 69.2

ELEVATION TOP DAM: 66.5

SPILLWAY CREST: Overflow concrete weir

a. Elevation 64.7 (Primary) 65.0 (Secondary)
b. Type 45° upstream face -two stage weir
c. Width 1 foot
d. Length 24 ft. (primary) 39 ft. (secondary)
e. Location Spillover Upstream side of dam - 5-sided drop inlet
f. Number and Type of Gates N.A.

OUTLET WORKS: 1-36" RCP

a. Type Reinforced concrete pipe with stoplog gate at upstream end
b. Location Approx 50 ft. right of spillway
c. Entrance inverts 60.1
d. Exit inverts 59.0
e. Emergency draindown facilities: Outlet works reportedly not operable

HYDROMETEOROLOGICAL GAGES: None

a. Type N.A.
b. Location N.A.
c. Records N.A.

MAXIMUM NON-DAMAGING DISCHARGE:

(Lake stage equal to top of dam) 482 c.f.s.

APPENDIX 4

Hydraulic/Hydrologic Computations

HYDROLOGY

HYDROLOGIC ANALYSIS - INFLOW HYDROGRAPH

WILL BE DEVELOPED BY THE HEC-1-DB COMPUTER PROGRAM USING THE SNYDER METHOD, AND ROUTED BY THE MODIFIED PULS METHOD.

SNYDERS COEFFICIENTS

$C_t = 2.0$
$C_p = 0.6$
} SUPPLIED BY CORPS OF ENGINEERS

$t_p = C_t (LL_c)^{0.3}$ where:

- t_p: LAG TIME (HOURS)
- C_t: COEFFICIENT REPRESENTING VARIATIONS OF WATERSHED SLOPES & STORAGES
- L: LENGTH OF MAIN CHANNEL FROM OUTLET TO DIVIDE (MILES)
- L_c: LENGTH OF MAIN CHANNEL FROM OUTLET TO A POINT ON STREAM NEAREST CENTROID OF WATERSHED (MILES)

$L = 9.85$ MILES ; $L_c = 4.2$ MILES

$t_p = C_t (LL_c)^{0.3}$; $t_p = 2.0 (9.85 \times 4.2)^{0.3}$

$t_p = 6.1$ HOURS

DRAINAGE AREA, DA

FROM USGS QUADRANGLES: HIGHTSTOWN, ALLENTOWN, PRINCETON

DRAINAGE AREA = 12.3 SQUARE MILES

PRECIPITATION (Ref. "DESIGN OF SMALL DAMS" USDI 1977, FIGURE 15)

PROBABLE MAXIMUM PRECIPITATION = 26.2 INCHES FOR 6 HOUR DURATION & 10 SQ MI. D.A.

DURATION (hr.)	% PMP
6	98
12	107
24	115

INFILTRATION DATA

DRAINAGE BASIN MAINLY WOODED

USE: INITIAL INFILTRATION = 1.5 INCHES
CONSTANT INFILTRATION = 0.15 INCHES/HOUR

LAKE STORAGE VOLUME

WATER SURFACE ELEVATION	AREA (ACRES)
56	0
62	26
64	42
66	50
68	63
70	85

HEC-1-DB COMPUTER PROGRAM WILL DEVELOP STORAGE CAPACITY FROM SURFACE AREAS & ELEVATIONS.

INFORMATION TAKEN FROM WEST WINDSOR TOWNSHIP TOPOGRAPHIC MAP

HYDRAULICS

THE SPILLWAY AT GROVERS MILL DAM IS A TWO STAGE, HORSESHOE, FREE OVERFLOW, CONCRETE SPILLWAY. THE PRIMARY CREST IS AT ELEVATION 64.7 WITH AN EFFECTIVE LENGTH OF 24 FEET. THE SECONDARY CREST IS AT ELEVATION 65.0 WITH AN EFFECTIVE LENGTH OF 39 FEET.

DISCHARGE WILL BE CALCULATED USING THE FORMULA, $Q = CLH^{3/2}$ WHERE: Q = discharge over spillway
C = coefficient of discharge
L = length of spillway
H = total head on spillway

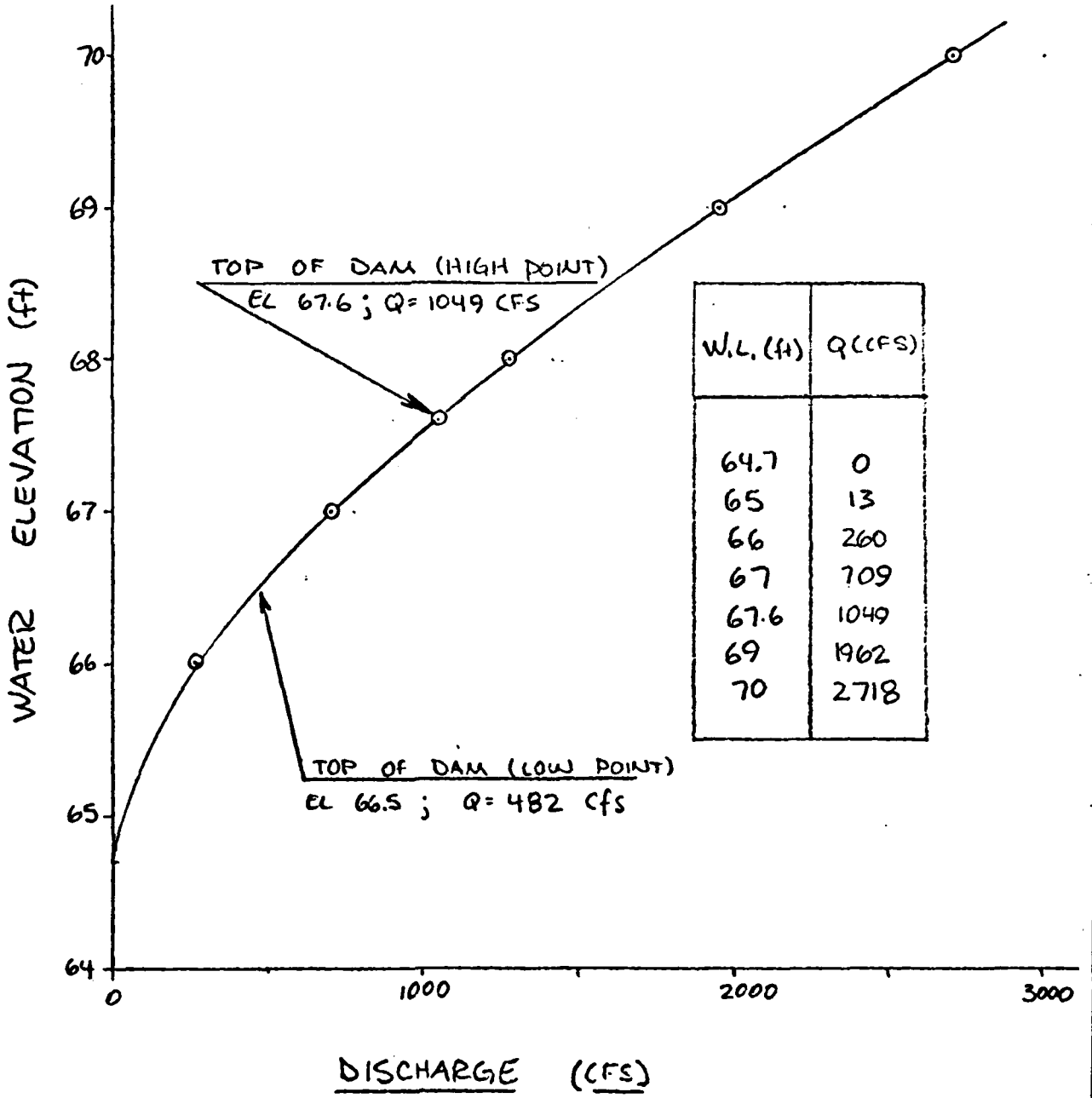
DISCHARGE VALUES IN THE FOLLOWING TABULATION DO NOT INCLUDE OVERTOPPING OF 430' OF DAM CREST AT ELEVATION 66.5, AS THIS WILL BE COMPUTED BY THE HEC-1-DB COMPUTER PROGRAM. THE TOP OF DAM ELEVATION VARIES FROM A LOW POINT OF 66.5 TO A HIGH POINT OF 67.6; THEREFORE, IN ANY TOP OF DAM ANALYSIS, THE CONSERVATIVE ELEVATION OF 66.5 WILL BE USED.

STAGE - DISCHARGE TABULATION

WATER ELEVATION	PRIMARY CREST EL 64.7 L= 24'			SECONDARY CREST EL 65.0 L= 39'			TOTAL DISCHARGE
	H_1 (ft.)	C_1	Q_1 (c.f.s.)	H_2 (ft.)	C_2	Q_2 (c.f.s.)	Q_1+Q_2 (c.f.s.)
64.7	0	-	0	0	-	0	0
65	0.3	3.41	13	0	-	0	13
66	1.3	3.57	127	1	3.41	133	260
67	2.3	3.65	306	2	3.65	403	709
67.6	2.9	3.72	441	2.6	3.72	608	1049
68	3.3	3.73	537	3	3.72	754	1291
69	4.3	3.73	798	4	3.73	1164	1962
70	5.3	3.73	1092	5	3.73	1626	2718
71	6.3	3.73	1416	6	3.73	2138	3554
72	7.3	3.73	1766	7	3.73	2694	4460

NOTE: VALUES FOR "C" TAKEN FROM "HANDBOOK OF HYDRAULICS" BY BRATER & KING pg 5-44

STAGE - DISCHARGE CURVE



W.L. (ft)	Q (CFS)
64.7	0
65	13
66	260
67	709
67.6	1049
69	1962
70	2718

OUTLET WORKS CAPACITY

OUTLET WORKS FOR THE GROVERS MILL DAM CONSIST OF A 36" DIAMETER RCP, 42 FEET LONG. INLET INVERT AT 60.1, OUTLET INVERT AT 59.0.

FROM "HYDRAULIC CHARTS FOR THE SELECTION OF HIGHWAY CULVERTS" - BUREAU OF PUBLIC ROADS, 1963; INLET CONTROLS (FROM CHART # 2)

MAXIMUM DISCHARGE; H_w = 5.0'
Q = 61 CFS

AVERAGE DISCHARGE; H_w = 2.5' (DURING DRAWDOWN)
Q = 27 CFS

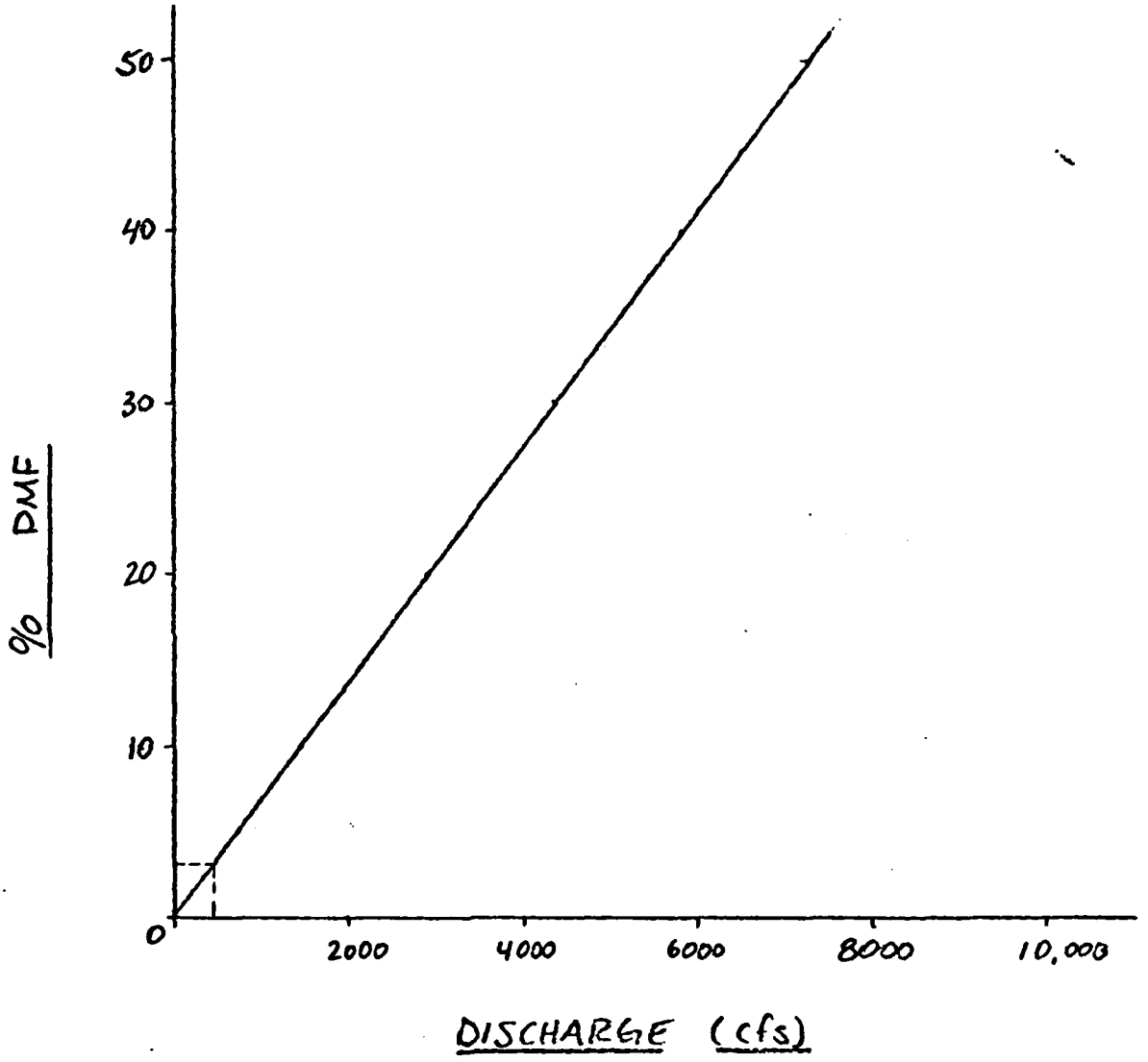
DRAWDOWN

$$\text{DRAWDOWN} = \frac{\text{STORAGE AT SPILLWAY}}{\text{AVERAGE DISCHARGE - AVERAGE INFLOW}}$$

$$= \frac{150 \text{ AC-FT} \quad (43560^{SF/AC})}{27 \text{ CFS} - (1 \text{ CFS/SM} \times 12.35 \text{SM})(3600^{SEC/HR})}$$

DRAWDOWN = 123 HOURS = 5.1 DAYS

OVERTOPPING POTENTIAL



OVERTOPPING OF THE CREST OF THE DAM OCCURS FIRST AT THE LOW POINT AT ELEVATION 66.5. DISCHARGE OVER THE SPILLWAY AT THIS MOMENT IS 482 CFS.

∴ DAM CAN PASS APPROXIMATELY 3% PMF OR 6% SDF.

HEC-1-DB COMPUTATIONS

```
A1       NATIONAL DAM SAFETY PROGRAM
A2        GROVERS MILL DAM
A3       MULTI RATIO PMF ROUTING
B     150          1         0                                    0         0         3
B1      5
J       1          5         1
J1    0.5        0.4       0.3       0.2       0.1
K       0       LAKE                          0         0         1         0
K1       INFLOW HYDROGRAPH TO LAKE
M       1          1      12.3                 12.3         0                   1
P       0       26.2        98       107       115
T                                                        1.5      0.15
W     6.1        0.6
X    -1.0      -0.05       2.0
K       1        DAM                          0         0         1
K1       ROUTE DISCHARGE THROUGH DAM
Y                                    1         1
Y1      1                                                -65.1        -1
Y4   64.7         65        66        67      67.6        68        69        70        71        72
Y5      0         13       260       703      1049      1291      1962      2718      3554      4460
YA      0         26        42        50        63        85
YE     56         62        64        66        68        70
YI   64.7
YD   66.5       2.63       1.5       430
Y      99
A
A
A
A
A
```

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**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  26 FEB 79
**********

RUN  DATE= 80/01/28.
     TIME= 10.11.37.

                    NATIONAL DAM SAFETY PROGRAM
                     GROVERS MILL DAM
                     MULTI RATIO PMF ROUTING

                                    JOB SPECIFICATION
          NQ      NHR      NMIN     IDAY      IHR      IMIN     METRC      IPLT      IPRT    NSTAN
         150        1         0        0        0        0        0         0         3        0
                                    JOPER      NWT     LROPT     TRACE
                                        5        0         0         0

                                 MULTI-PLAN ANALYSES TO BE PERFORMED
                                       NPLAN= 1  NRTIO= 5  LRTIO= 1
                    RTIOS=     .50      .40      .30      .20      .10

**********          **********          **********          **********          **********
                                 SUB-AREA RUNOFF COMPUTATION
                    INFLOW HYDROGRAPH TO LAKE
                                   ISTAQ    ICOMP    IECON    ITAPE    JPLT     JPRT    INAME  ISTAGE   IAUTO
                                   LAKE         0        0        0       0        0        1       0       0
                                                HYDROGRAPH DATA
                          IHYDG    IUHG     TAREA     SNAP     TRSDA     TRSPC     RATIO    ISNOW    ISAME   LOCAL
                              1       1     12.30     0.00     12.30      0.00     0.000        0        1       0
                                                PRECIP DATA
                           SPFE      PMS       R6       R12       R24       R48       R72       R96
                           0.00    26.20    98.00    107.00    115.00      0.00      0.00      0.00
TRSPC COMPUTED BY THE PROGRAM IS  .807
                                                LOSS DATA
                    LROPT   STRKR    DLTKR    RTIOL    ERAIN    STRKS    RTIOK    STRTL    CNSTL    ALSMX    RTIMP
                        0    0.00     0.00     1.00     0.00     0.00     1.00     1.50      .15      0.00     0.00
                                             UNIT HYDROGRAPH DATA
                                         TP=  6.10    CP= .60    NTA=  0
                                             RECESSION DATA
                                   STRTQ=   -1.00    QRCSN=    -.05    RTIOR= 2.00
APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 6.95 AND R= 5.88 INTERVALS

                UNIT HYDROGRAPH 35 END-OF-PERIOD ORDINATES, LAG=  6.07 HOURS, CP=  .60  VOL= 1.00
                  48.     176.     350.     538.     696.     785.     793.     713.     601.     507.
                 427.     360.     304.     256.     216.     182.     154.     130.     109.      92.
                  78.      66.      55.      47.      39.      33.      28.      24.      20.      17.
                  14.      12.      10.       8.       7.
```

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	1.00	1	.11	0.00	.11	11.
1.01	2.00	2	.11	0.00	.11	11.
1.01	3.00	3	.11	0.00	.11	10.
1.01	4.00	4	.11	0.00	.11	9.
1.01	5.00	5	.11	0.00	.11	9.
1.01	6.00	6	.11	0.00	.11	8.
1.01	7.00	7	.32	0.00	.32	8.
1.01	8.00	8	.32	0.00	.32	7.
1.01	9.00	9	.32	.07	.25	10.
1.01	10.00	10	.32	.17	.15	26.
1.01	11.00	11	.32	.17	.15	67.
1.01	12.00	12	.32	.17	.15	138.
1.01	13.00	13	2.07	1.92	.15	322.
1.01	14.00	14	2.49	2.34	.15	774.
1.01	15.00	15	3.11	2.96	.15	1623.
1.01	16.00	16	7.88	7.73	.15	3178.
1.01	17.00	17	2.90	2.75	.15	5553.
1.01	18.00	18	2.28	2.13	.15	8411.
1.01	19.00	19	.17	.02	.15	11252.
1.01	20.00	20	.17	.02	.15	13435.
1.01	21.00	21	.17	.02	.15	14543.
1.01	22.00	22	.17	.02	.15	14475.
1.01	23.00	23	.17	.02	.15	13347.
1.02	0.00	24	.17	.02	.15	11675.
1.02	1.00	25	0.00	0.00	0.00	9962.
1.02	2.00	26	0.00	0.00	0.00	8422.
1.02	3.00	27	0.00	0.00	0.00	7119.
1.02	4.00	28	0.00	0.00	0.00	6015.
1.02	5.00	29	0.00	0.00	0.00	5080.
1.02	6.00	30	0.00	0.00	0.00	4288.
1.02	7.00	31	0.00	0.00	0.00	3617.
1.02	8.00	32	0.00	0.00	0.00	3059.
1.02	9.00	33	0.00	0.00	0.00	2572.
1.02	10.00	34	0.00	0.00	0.00	2169.
1.02	11.00	35	0.00	0.00	0.00	1830.
1.02	12.00	36	0.00	0.00	0.00	1543.
1.02	13.00	37	0.00	0.00	0.00	1301.
1.02	14.00	38	0.00	0.00	0.00	1098.
1.02	15.00	39	0.00	0.00	0.00	926.
1.02	16.00	40	0.00	0.00	0.00	781.
1.02	17.00	41	0.00	0.00	0.00	700.
1.02	18.00	42	0.00	0.00	0.00	653.
1.02	19.00	43	0.00	0.00	0.00	609.
1.02	20.00	44	0.00	0.00	0.00	568.
1.02	21.00	45	0.00	0.00	0.00	530.
1.02	22.00	46	0.00	0.00	0.00	495.
1.02	23.00	47	0.00	0.00	0.00	462.
1.03	0.00	48	0.00	0.00	0.00	431.
1.03	1.00	49	0.00	0.00	0.00	402.
1.03	2.00	50	0.00	0.00	0.00	375.
1.03	3.00	51	0.00	0.00	0.00	350.
1.03	4.00	52	0.00	0.00	0.00	326.
1.03	5.00	53	0.00	0.00	0.00	305.
1.03	6.00	54	0.00	0.00	0.00	284.
1.03	7.00	55	0.00	0.00	0.00	265.
1.03	8.00	56	0.00	0.00	0.00	247.
1.03	9.00	57	0.00	0.00	0.00	231.
1.03	10.00	58	0.00	0.00	0.00	215.
1.03	11.00	59	0.00	0.00	0.00	201.
1.03	12.00	60	0.00	0.00	0.00	187.
1.03	13.00	61	0.00	0.00	0.00	175.
1.03	14.00	62	0.00	0.00	0.00	163.
1.03	15.00	63	0.00	0.00	0.00	152.
1.03	16.00	64	0.00	0.00	0.00	142.
1.03	17.00	65	0.00	0.00	0.00	133.
1.03	18.00	66	0.00	0.00	0.00	124.
1.03	19.00	67	0.00	0.00	0.00	115.
1.03	20.00	68	0.00	0.00	0.00	108.
1.03	21.00	69	0.00	0.00	0.00	101.
1.03	22.00	70	0.00	0.00	0.00	94.
1.03	23.00	71	0.00	0.00	0.00	87.
1.04	0.00	72	0.00	0.00	0.00	82.
1.04	1.00	73	0.00	0.00	0.00	76.
1.04	2.00	74	0.00	0.00	0.00	71.
1.04	3.00	75	0.00	0.00	0.00	66.

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.04	4.00	76	0.00	0.00	0.00	62.
1.04	5.00	77	0.00	0.00	0.00	58.
1.04	6.00	78	0.00	0.00	0.00	54.
1.04	7.00	79	0.00	0.00	0.00	50.
1.04	8.00	80	0.00	0.00	0.00	47.
1.04	9.00	81	0.00	0.00	0.00	44.
1.04	10.00	82	0.00	0.00	0.00	41.
1.04	11.00	83	0.00	0.00	0.00	38.
1.04	12.00	84	0.00	0.00	0.00	36.
1.04	13.00	85	0.00	0.00	0.00	33.
1.04	14.00	86	0.00	0.00	0.00	31.
1.04	15.00	87	0.00	0.00	0.00	29.
1.04	16.00	88	0.00	0.00	0.00	27.
1.04	17.00	89	0.00	0.00	0.00	25.
1.04	18.00	90	0.00	0.00	0.00	23.
1.04	19.00	91	0.00	0.00	0.00	22.
1.04	20.00	92	0.00	0.00	0.00	20.
1.04	21.00	93	0.00	0.00	0.00	19.
1.04	22.00	94	0.00	0.00	0.00	18.
1.04	23.00	95	0.00	0.00	0.00	17.
1.05	0.00	96	0.00	0.00	0.00	15.
1.05	1.00	97	0.00	0.00	0.00	14.
1.05	2.00	98	0.00	0.00	0.00	13.
1.05	3.00	99	0.00	0.00	0.00	13.
1.05	4.00	100	0.00	0.00	0.00	12.
1.05	5.00	101	0.00	0.00	0.00	11.
1.05	6.00	102	0.00	0.00	0.00	10.
1.05	7.00	103	0.00	0.00	0.00	10.
1.05	8.00	104	0.00	0.00	0.00	9.
1.05	9.00	105	0.00	0.00	0.00	8.
1.05	10.00	106	0.00	0.00	0.00	8.
1.05	11.00	107	0.00	0.00	0.00	7.
1.05	12.00	108	0.00	0.00	0.00	7.
1.05	13.00	109	0.00	0.00	0.00	6.
1.05	14.00	110	0.00	0.00	0.00	6.
1.05	15.00	111	0.00	0.00	0.00	5.
1.05	16.00	112	0.00	0.00	0.00	5.
1.05	17.00	113	0.00	0.00	0.00	5.
1.05	18.00	114	0.00	0.00	0.00	4.
1.05	19.00	115	0.00	0.00	0.00	4.
1.05	20.00	116	0.00	0.00	0.00	4.
1.05	21.00	117	0.00	0.00	0.00	4.
1.05	22.00	118	0.00	0.00	0.00	3.
1.05	23.00	119	0.00	0.00	0.00	3.
1.06	0.00	120	0.00	0.00	0.00	3.
1.06	1.00	121	0.00	0.00	0.00	3.
1.06	2.00	122	0.00	0.00	0.00	3.
1.06	3.00	123	0.00	0.00	0.00	2.
1.06	4.00	124	0.00	0.00	0.00	2.
1.06	5.00	125	0.00	0.00	0.00	2.
1.06	6.00	126	0.00	0.00	0.00	2.
1.06	7.00	127	0.00	0.00	0.00	2.
1.06	8.00	128	0.00	0.00	0.00	2.
1.06	9.00	129	0.00	0.00	0.00	2.
1.06	10.00	130	0.00	0.00	0.00	1.
1.06	11.00	131	0.00	0.00	0.00	1.
1.06	12.00	132	0.00	0.00	0.00	1.
1.06	13.00	133	0.00	0.00	0.00	1.
1.06	14.00	134	0.00	0.00	0.00	1.
1.06	15.00	135	0.00	0.00	0.00	1.
1.06	16.00	136	0.00	0.00	0.00	1.
1.06	17.00	137	0.00	0.00	0.00	1.
1.06	18.00	138	0.00	0.00	0.00	1.
1.06	19.00	139	0.00	0.00	0.00	1.
1.06	20.00	140	0.00	0.00	0.00	1.
1.06	21.00	141	0.00	0.00	0.00	1.
1.06	22.00	142	0.00	0.00	0.00	1.
1.06	23.00	143	0.00	0.00	0.00	1.
1.07	0.00	144	0.00	0.00	0.00	1.
1.07	1.00	145	0.00	0.00	0.00	1.
1.07	2.00	146	0.00	0.00	0.00	0.
1.07	3.00	147	0.00	0.00	0.00	0.
1.07	4.00	148	0.00	0.00	0.00	0.
1.07	5.00	149	0.00	0.00	0.00	0.
1.07	6.00	150	0.00	0.00	0.00	0.
		SUM	24.32	20.51	3.81	169118.
			(618.)	(521.)	(97.)	(4788.89)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	14543.	13014.	6775.	2339.	169113.
CMS	412.	369.	192.	66.	4789.
INCHES		9.84	19.59	21.23	21.32
MM		249.99	497.52	539.28	541.43
AC-FT		6453.	12843.	13921.	13976.
THOUS CU M		7960.	15841.	17171.	17239.

HYDROGRAPH AT STA LAKE FOR PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	7271.	6507.	3237.	1170.	84556.
CMS	206.	184.	92.	33.	2394.
INCHES		4.92	9.79	10.62	10.66
MM		124.99	248.76	269.64	270.72
AC-FT		3227.	6421.	6960.	6988.
THOUS CU M		3980.	7921.	8585.	8620.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE DISCHARGE THROUGH DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
DAM	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-65.	-1

STAGE	64.70	65.00	66.00	67.00	67.60	68.00	69.00	70.00	71.00	72.00
FLOW	0.00	13.00	260.00	703.00	1049.00	1291.00	1962.00	2718.00	3554.00	4460.00
SURFACE AREA=	0.	26.	42.	50.	63.	85.				
CAPACITY=	0.	52.	119.	211.	324.	471.				
ELEVATION=	56.	62.	64.	66.	68.	70.				

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
64.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
66.5	2.6	1.5	430.

STATION DAM, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

26.	19.	14.	13.	12.	11.	11.	10.	10.	10.
11.	17.	52.	131.	311.	1017.	2401.	3784.	5253.	6452.
7167.	7282.	6852.	6069.	5209.	4412.	3730.	3157.	2673.	2261.
1913.	1617.	1368.	1157.	984.	836.	711.	606.	520.	461.
414.	375.	344.	318.	295.	274.	257.	246.	233.	220.
206.	194.	181.	169.	158.	148.	138.	129.	120.	112.
105.	98.	91.	85.	79.	74.	69.	64.	60.	56.
52.	49.	45.	42.	39.	37.	34.	32.	30.	28.
26.	24.	23.	21.	20.	18.	17.	16.	15.	14.
13.	13.	13.	12.	12.	12.	11.	11.	11.	10.
10.	10.	9.	9.	9.	8.	8.	8.	7.	7.
7.	6.	6.	6.	6.	5.	5.	5.	5.	4.
4.	4.	4.	4.	3.	3.	3.	3.	3.	3.
2.	2.	2.	2.	2.	2.	2.	2.	2.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.

STORAGE

166.	164.	163.	163.	162.	162.	161.	160.	160.	160.
161.	164.	171.	186.	217.	261.	301.	333.	366.	393.
408.	410.	401.	384.	365.	348.	332.	319.	307.	297.
288.	280.	272.	266.	260.	255.	250.	245.	240.	235.
229.	224.	221.	218.	215.	213.	211.	208.	206.	203.
200.	198.	195.	193.	191.	189.	187.	185.	184.	182.
181.	179.	178.	177.	176.	175.	174.	173.	172.	171.
171.	170.	169.	169.	168.	168.	167.	167.	166.	166.
166.	165.	165.	165.	165.	164.	164.	164.	164.	163.
163.	163.	163.	163.	162.	162.	162.	161.	161.	161.
160.	160.	160.	159.	159.	158.	158.	158.	157.	157.
157.	156.	156.	156.	155.	155.	155.	155.	154.	154.
154.	154.	154.	153.	153.	153.	153.	153.	152.	152.
152.	152.	152.	152.	152.	152.	151.	151.	151.	151.
151.	151.	151.	151.	151.	151.	151.	151.	151.	151.

STAGE

65.1	65.0	65.0	65.0	65.0	65.0	64.9	64.9	64.9	64.9
64.9	65.0	65.2	65.5	66.1	66.9	67.6	68.1	68.6	69.0
69.2	69.2	69.1	68.9	68.6	68.4	68.1	67.9	67.7	67.6
67.4	67.3	67.1	67.0	66.9	66.8	66.7	66.6	66.6	66.5
66.3	66.3	66.2	66.1	66.1	66.0	66.0	65.9	65.9	65.8
65.8	65.7	65.7	65.6	65.6	65.5	65.5	65.5	65.4	65.4
65.4	65.3	65.3	65.3	65.3	65.2	65.2	65.2	65.2	65.2
65.2	65.1	65.1	65.1	65.1	65.1	65.1	65.1	65.1	65.1
65.1	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0
65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	64.9	64.9
64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9
64.9	64.8	64.8	64.8	64.8	64.8	64.8	64.8	64.8	64.8
64.8	64.8	64.8	64.8	64.8	64.8	64.8	64.8	64.8	64.8
64.8	64.8	64.7	64.7	64.7	64.7	64.7	64.7	64.7	64.7
64.7	64.7	64.7	64.7	64.7	64.7	64.7	64.7	64.7	64.7

PEAK OUTFLOW IS 7282. AT TIME 22.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	7282.	6509.	3222.	1169.	84749.
CMS	206.	184.	91.	33.	2400.
INCHES		4.92	9.75	10.61	10.68
MM		125.03	247.57	269.50	271.33
AC-FT		3227.	6391.	6957.	7004.
THOUS CU M		3981.	7883.	8581.	8639.

SUMMARY OF DAM SAFETY ANALYSIS

•••••••••		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	ELEVATION	65.10	64.70	66.50
	STORAGE	148.	190.	237.
	OUTFLOW	38.	0.	482.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	68.24	2.74	410.	7282.	24.00	22.00	0.00
.40	68.12	2.32	379.	5626.	23.00	22.00	0.00
.30	68.35	1.85	347.	4370.	20.00	22.00	0.00
.20	67.83	1.33	315.	2913.	18.00	22.00	0.00
.15	67.19	.69	275.	1456.	12.00	22.00	0.00

APPENDIX 5

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